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ABSTRACT

Developed as a means of integrating mathematics skills and science processes, this booklet focuses on activities dealing with geology, oceanography, and meteorology for students of grades five through eight. Twenty mathematics skills and 11 science processes are listed and indexed for the 18 activities. Each activity consists of student sheets and a teacher's guide. The teacher's guide contains information on the activities including: (1) topic area; (2) introductory statement; (3) math and science skills; (4) required materials; (5) key questions; (6) background information; (7) management details; (8) instructional procedures; (9) student procedures; (10) discussion questions; (11) activity extensions; and (12) curriculum coordinates. (ML)

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DOWN TO EARTH

Solutions for MATH + SCIENCE

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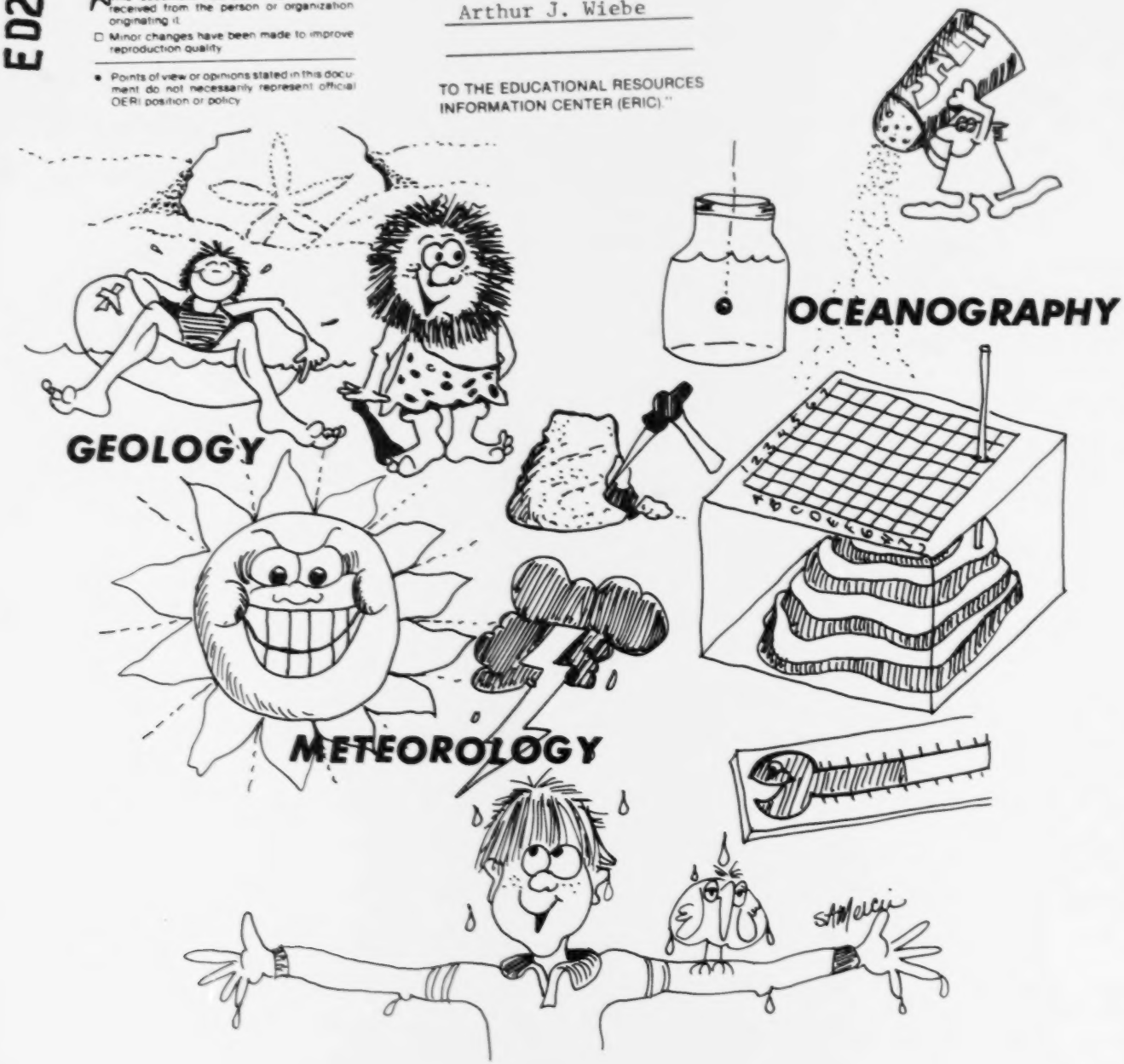

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BOOK 6

EARTH SCIENCE

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Project AIMS

Project AIMS has as its purpose the integration of subject matter in K-9. Such integration enriches and makes learning meaningful and holistic. Project AIMS began as a program to integrate mathematics and science, but has since developed to also include language arts, social studies, and other disciplines. The acronym "AIMS" stands for "activities to integrate mathematics and science."

Project AIMS is a continuing, non-profit project of Fresno Pacific College. It had its inception in a National Science Foundation funded program to train teachers in the integration of mathematics and science. This quickly created the necessity to write instructional materials incorporating this concept. Despite the fact that thoughtful educators have long recommended this approach, very little appropriate material was available.

Currently, Project AIMS is funded solely through the sale of this developing series of books. All net proceeds from their sale flow into a trust fund administered by Fresno Pacific College. The use of this fund is restricted to the support of continued research and development, partial scholarships for classroom teachers who participate in the writing and field testing teams, and the publication of the books.

Two writing teams have completed their work. The first consisted of seventy-five teachers in grades 5-9 who met over a period of eighteen months. The second involved thirty-five K-4 teachers who wrote during a two-year span. In the fall of 1985 a third team of approximately fifty teachers in grades 2-9 will begin writing. In addition, over a hundred teachers have been involved in field testing newly created materials.

The rationale for this integrative thrust lies in the fact that science, mathematics, language arts, social studies, etc., are integrally interwoven in the real world outside the classroom, from which it follows that they should be similarly treated in the classroom if we are to prepare our students for life in that world. Teachers who have used Project AIMS lessons give enthusiastic endorsement to the effectiveness of this approach.

Science encompasses the art of questioning, investigating, hypothesizing, and discovering. Mathematics is the language that provides clarity, objectivity, and understanding. The language arts provide us with powerful tools of communication. Many of the major contemporary issues involve societal issues stemming from advancements in science. It is time, therefore, that all of us in the teaching profession take seriously using a more holistic mode of transmitting knowledge to students. It is this that motivates all of us who are involved in creating or using the integrative materials of Project AIMS. We invite you to join us in this effort.

Extensive field testing of these materials confirms the following beneficial results.

1. Mathematics becomes more meaningful, hence more useful, when it is applied to situations that interest students.

2. The extent to which science is studied and understood is increased, with a significant economy of time resulting from the integration of two or more disciplines.

3. There is improved quality of learning and retention, supporting the thesis that learning which is meaningful and relevant is more effective.

4. Motivation and involvement are increased dramatically as students investigate real world situations and participate actively in the process.

We invite you to become part of this classroom teacher movement by using an integrated approach and by sharing any suggestions you may have or investigations you would recommend. Project AIMS welcomes you!

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Down to Earth
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I HEAR, AND I FORGET

I SEE, AND I REMEMBER

I DO, AND I UNDERSTAND

–Chinese Proverb

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Dripping Wet

I. **Topic Area**

Relative humidity derived from wet-bulb and dry-bulb temperatures.

II. **Introductory Statement**

Upon completion of this activity, students will be able to explain the relationship between humidity and relative humidity and the importance of moisture in the air.

III. **Math Skills**

a. Adding
b. Subtracting
c. Dividing
d. Averaging
e. Using decimals
f. Converting
g. Graphing

Science Processes

a. Collecting data
b. Comparing
c. Predicting
d. Interpreting data
e. Drawing conclusions

IV. **Materials**

12 thermometers
6 cotton balls
Student worksheets, pages 1-5

V. **Key Question**

How much moisture is in the air?

VI. **Background Information**

1. Vocabulary: humidity, relative humidity, wet-bulb thermometer, dry-bulb thermometer, conversion table, bar graph, line graph.
2. The wet- and dry-bulb thermometer stations should be established in different environmental conditions (indoors and out, shaded and sunny, open to breeze and protected).
3. To make wet-bulb thermometers, saturate and attach a cotton ball to each of six thermometers. When starting the thermometer readings, be sure to allow enough time for the wet cotton's temperature to normalize.
4. In developing the vocabulary, be sure to explain that wet- and dry-bulb thermometers are used to determine relative humidity.
5. Relative humidity is a measure of how close air is to its saturation point. To determine relative humidity, the amount of moisture in the air is measured. This measurement is compared to the amount of moisture air could hold at that temperature. At its saturation point, air is said to have a relative humidity of 100%.

VII. **Management Suggestions**

Timeline:

1. One 45-minute preparation period for developing the vocabulary and preparing the stations.
2. One 20- to 30-minute period each of 5 days for gathering data and recording it on student worksheet page 1.
3. Two 45-minute periods for graphing the data and discussing the questions on student worksheets pages 3-5.

VIII. **Procedure**

1. On the first day, discuss the project and vocabulary, divide the class into six groups, and establish the data-collecting stations (you may prefer to establish the stations yourself prior to this time).
2. On the second day, distribute student worksheet page 1 and have the groups visit each station, recording the temperature of each thermometer. Using the conversion table on student worksheet page 2, have each student determine the percent of relative humidity for each of the stations. Compute the total and average the temperatures.
3. On the third through sixth days, repeat the steps from the second day's activities.
4. On the seventh and eighth days, complete the line and bar graphs and answer the discussion questions on student worksheets pages 3-5.

X. **Discussion**

Use the questions on student worksheets pages 3-4.

XI. **Extension**

1. Encourage students to develop their own graphs.
2. Average the groups' data to form one graph for the class.
3. Encourage students to do this investigation at home, reporting the results to the class.
4. For classes that rotate rooms/teachers, compare data gathered by morning classes with that gathered by afternoon groups.
5. For self-contained classes, gather data in both morning and afternoon and compare results.

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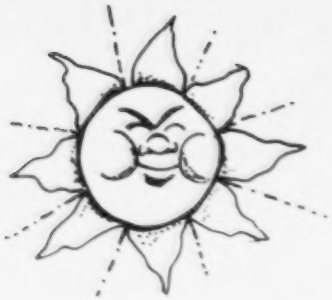

When You're Hot, You're Hot !

I. **Topic Area**

Heat absorption and radiant and solar energy.

II. **Introductory Statement**

Upon completion of this activity, students will be aware of heat absorption and radiant and solar energy.

III. **Math Skills**

a. Averaging
b. Graphing

Science Processes

a. Observing
b. Measuring
c. Recording data

IV. **Materials**

8 one-gallon plastic containers
1 can flat black spray paint
1 can flat white spray paint
8 thermometers
String
Student worksheets, pages 6 and 7

V. **Key Question**

Given the same conditions, does a black container of water or a white container of water attain a higher temperature?

VI. **Management Suggestions**

1. At least one day before doing the investigation paint 4 containers black and 4 containers white.
2. As this is an on-going process, data can be taken for 1 to 3 weeks.
3. Take readings at regular intervals (suggestion: 9 a.m., 12 noon, and 3 p.m.).

VII. **Procedure**

1. Divide class into four groups.
2. Each group should choose a location for their containers where the containers will not be disturbed. Two of the groups should choose a shady location and the other two should choose a sunny location.
3. Each group should fill a black and a white container with water, tie string to the thermometers and the container handles, and immerse the thermometers in the water.
4. Let the containers sit for a day to equalize the temperatures.
5. Groups should record temperatures and weather conditions regularly.
6. Students should graph the three daily readings, using different colored lines for each of their two sets of data.
7. Students should average the data for the two "sunny" groups and the two "shady" groups and create graphs for each, comparing the results. (Use multiple copies of student worksheet page 7.)

VIII. **What the Students Will Do**

1. Students will fill containers with water, immerse a thermometer in each, and place the containers in appropriate locations.
2. Students will gather data three times per day, recording and graphing this information.
3. Students will average and graph the groups' results.

X. **Discussion**

1. Is there a difference in temperature because of the color of the containers?
2. Is there a difference in temperature because of the location?
3. Is there a difference in temperature because of the time of day the readings were taken?
4. Is there a difference in temperature because of the weather conditions?
5. What conclusions can you draw from these differences?

XI. **Extension**

1. Use different solutions in the containers (salt, sugar, et al.).
2. Use sand rather than solutions.
3. Encourage students to continue this investigation at home, reporting the results to the class.
4. Create a composite graph, bulletin-board size, and "go on tour," explaining the investigation and the outcome to other classes.

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HOT SPOT

I. **Topic Area**

The sun's angle and its effect on energy received.

II. **Introductory Statement**

Upon the completion of this activity, students will be able to state the relationship of the angle of the sun to the energy received.

III. **Math Skills**

a. Measuring angles, lengths, and temperature
b. Graphing
c. Finding area of rectangles

Science Processes

a. Recording data
b. Interpreting data
c. Generalizing

IV. **Materials**

Each group will need:
2 sheets black construction paper (8½" x 11")
Ring stand (or something on which to hang the thermometer)
Spotlight or lamp (150 watt, if possible)
Butcher paper (40 cm x 40 cm)
Thermometer
Metric Ruler
String (1 m)
Scissors
Protractor
Glue or tape
Overhead projector
Student worksheet page 8

V. **Key Question**

Why is it so much hotter at lunch recess in June than it is in December?

VI. **Background Information**

When asked the key question, many students will answer that the earth is closer to the sun in June. However, scientists have determined that the earth is actually closest to the sun on January first and farthest away from the sun on July first. When informed of this, students have a dilemma which will draw them into the investigation for a solution.

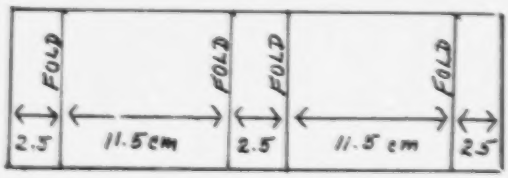
Seasonal temperature changes are a result of changes in the angle of incidence (the angle at which light hits the earth) as the earth revolves around the sun. The earth's axis is not perpendicular to its orbit around the sun, but is slanted at a 23½° angle. This means that the Northern Hemisphere during the winter months is pointed away from the sun and in the summer months is pointed towards the sun. As a result, during the winter the sun appears lower in the sky than it does in the summer, and its light hits the Northern Hemisphere at a smaller angle of incidence. This makes the same amount of light energy spread over a greater area. Therefore, not as much energy is received in any one spot.

VII. **Management Suggestions**

1. Time Schedule
   Day 1: Discuss key question, present procedure, draw up template, and build rectangular black box tube.
   Day 2: Run experiment, draw line graph, using different colors for temperature and area.
   Day 3: Short discussion (10-15 minutes) to bring closure to the experience.
2. Make sure students aim center of spotlight onto center of black box.
3. Divide students into groups of 3 or 4.
4. The wattage of the light and the distances are suggestions; others can be used. The teacher should test the equipment to see what will give the best results.

VIII. **Procedure**

1. Hand out butcher paper, protractors, and rulers; have students draw template as shown on student sheet.
2. Hand out black construction paper; fold and glue or tape 1 piece as shown below to make rectangular black tube; cut 1 cm square out of the center of the other.



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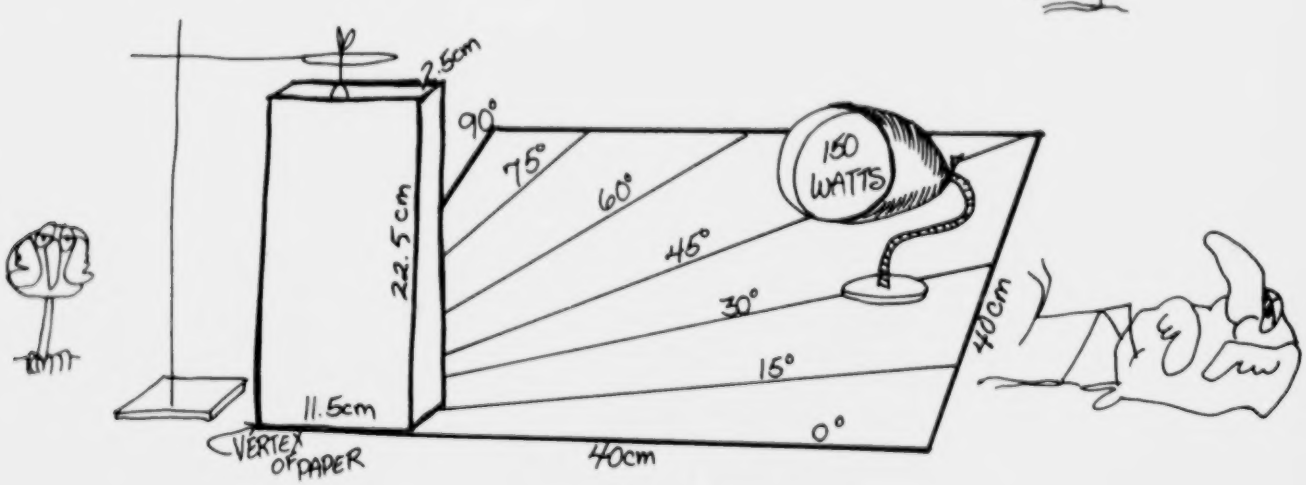
3. Place rectangular black tube on vertex of angles (with large flat side facing 90° mark).
4. Hang the thermometer from the ring stand so it hangs in the tube.
5. Place the spotlight on the 90° mark, 40 cm from the tube. Aim the light at the tube.
6. Turn the spotlight on for 5 minutes.
7. While waiting 5 minutes for the tube to warm up, students will work with the overhead projector. First tape a piece of graph paper on the wall in front of the overhead projector. Then place the piece of construction paper with the 1 cm square cutout on the projector. Using the string and protractor, adjust the lamp on the projector so that the light will be shining at the same angle to the graph paper as the spotlight is to the tube. Put the projector a meter from the paper. Turn on the projector and focus it. Determine how many square units are illuminated and record.
8. After 5 minutes, return to the thermometer. Read the temperature and record.
9. Cool off the tube by waving it in the air.
10. Replace tube, move light to next angle and repeat the sequence until you get to 0°.
11. Complete the graph.

X. **Discussion**

1. Why does the temperature go up as the number of degrees in the angle gets larger?
2. Why does the area get smaller as the number of degrees in the angle gets larger?
3. How do you explain that when the temperature is going up the area is going down?
4. How does this explain why it's warmer in June than it is in December or at noon than early in the morning?

XI. **Extension**

1. Use the black rectangular tube and thermometer to see how the sun affects temperatures. Use a clinometer to measure the angle of the sun. See if a graph of the sun's angle and temperature is similar to the experiment.
2. To get the best results with a solar cooker or heater, at what angle should you place it? Does your estimate match reality?



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Evap-o-Weight

I. **Topic Area**

Meteorology: Evaporation Rates

II. **Introductory Statement**

In this activity students will study the variables that affect evaporation rates by measuring the loss of mass through evaporation.

III. **Math Skills**

a. Measuring
b. Finding surface area
c. Using ratios
d. Graphing
e. Using formulas

Science Processes

a. Recording data
b. Controlling variables
c. Interpreting data

IV. **Materials**

Student Worksheet, pages 9-11
Thermometer
Wet bulb thermometer (optional)
Balance and masses (each group)
Straws (3 per group)
Pins (1 per group)
1 6"-9" length of lumber (preferably 2x2) per group
Bowls (1 per group)
Stopwatch or clock with second hand
Scissors
Rulers
Water

V. **Key Questions**

What weather conditions affect how fast things dry? What conditions cause the fastest drying?

VI. **Background Information**

The rate of evaporation is the result of the interrelationship between several environmental factors, the characteristics of the object containing the liquid, and the chemical makeup of the liquid itself.

There are four environmental factors which contribute to the rate of evaporation: temperature, wind, humidity and exposure, and intensity of sunlight.

The object itself affects the rate of evaporation by providing varieties of surface areas. Those objects that have more exposed surface allow more evaporation to take place. Objects that are porous or have small crevices insulate water from the environment and thus slow evaporation rates. Concrete will dry much faster than dirt since water does not penetrate concrete and remains exposed to the elements. The wicking action (the ability of a material to allow evaporated water to be replaced by moisture from deeper in the material) also affects the rate of evaporation.

In addition, the material evaporating also affects the rate of evaporation. From experience, most of us know that alcohol evaporates more quickly than water, and water evaporates more quickly than salt water.

VII. **Management Suggestions**

1. Timetable: Allow a minimum of 2½ 45-minute class periods:
   1 period to plan and do the initial activity
   1 period for groups to work on activities, independently testing chosen variables
   1/2 period to draw summaries from activities
2. As an alternative method to having the students choose the variables they want to test, you may choose which you would like the students to work with and have them all work together under your supervision.
3. This activity needs to be done with accurate measuring. Since scales vary in their sensitivity to weight loss, test yours so that you can make recommendations to your students about consistency in the measurement process.
4. Since the evaporation rate is the result of an interplay of several conditions, the students must keep all but one variable constant in order to accurately test the chosen condition. For example, it would not be accurate to test the effects of wind by doing one test in a warm, calm room and another on the cold, windy playground. The temperature as well as the wind would have varied.
5. Surface area directly affects the rate of evaporation. Stress to the students that they need to keep the surface areas the same (except when testing surface area). This is best done by cutting strips of equal widths and then folding them in half and hanging them similarly.
6. The first measurement tends to be the least accurate since excess drops of water will drop off and give sudden weight losses. You may discuss this with your students when they get their results.
7. When attempting the second part of the investigation, it may be necessary to wait for a breezy day or to use a fan if it is too calm.

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VIII. **Procedure**

1. Gather materials and assemble evaporative strip hanger (see illustration). Stand the 2"x2" piece upright. Place 1 straight pin through the center of 3 straws and attach it to the top of the 2"x2".
   If you have cup balances rather than platform balances, you can form the evaporative strip hangers by connecting two straws together to make one longer straw. Take two such straws and tape them together forming a cross that fits snugly on the cup. When the strips are hung on this cup, it may have to extend over the end of the table so that it will not drag.
   Day 1
2. Discuss the key question, plan the activity with the students, divide into groups and proceed with the investigation.
   Complete the graph. Discuss what weather conditions might change the rate of evaporation, and how one might design changes in the investigation to simulate these conditions.
   Day 2
4. Continue discussing the variables suggested on day 1, deciding which condition(s) the groups would like to test.
5. Test the chosen variables, recording data and graphing the results.
   Day 3
6. Discuss various findings and conclusions, and proceed to any extension activities desired.

X. **What the Students Will Do**

Day 1

1. Gather supplies: balance, masses, evaporative strip hanger, paper towels, bowl with water, watch or clock with second hand, scissors and ruler.
2. Cut the paper towels in six 7-cm strips and fold them in half lengthwise.
3. Test the length of one paper strip on the hanger, making sure that it does not touch the platform of the balance. Trim the excess, if any, and trim the remaining strips to match.
4. Soak the strips in water, wring out the excess liquid, and lay the fold of a strip over each straw of the hanger.
5. Gently shake off any excess water and place the hanger on one platform of the balance.
6. Quickly but carefully fill the other platform with weight until the balance is level.
7. Begin the timing, recording the time begun.
8. Watch the balance carefully. When it becomes slightly out of balance because of evaporation, remove one gram weight to bring it back to level. Record the time when you remove the weight.
9. Continue the process until you have removed 8 grams.
10. Complete the worksheet and graph the results.

Day 2

11. Decide which condition you will test:
    a. Temperature: change by going to different places (outside, inside, in a refrigerator, near a heater, etc.).
    b. Wind: find different wind velocities (calm, direct wind, around a sheltered corner outside, near a fan).
    c. Sunlight: try different strengths of sunlight (dark, heavy shade, bright shade, direct sunlight, morning sun, noon sun, etc.).
    d. Humidity: try out different humidities (use a wet bulb thermometer - optional, rainy, foggy, dry, clear).
    e. Surface Area: try different lenghts and widths of strips to see how they affect evaporation rates.
12. Using steps 1 through 10, test your condition in at least two different situations. Record and graph your results.

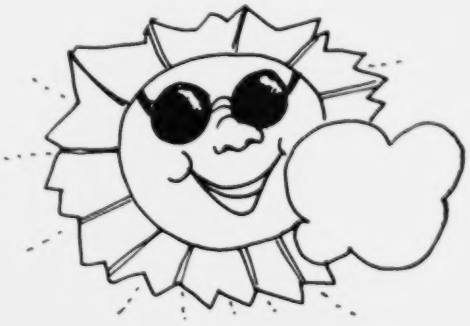
XI. **Discussion**

Day 1

1. Describe the pattern you see in your graph.
2. What does that pattern tell you about the evaporation rate?
3. If there are some points on your graph that do not fall in the pattern, what has caused that?
4. What could we do next time that might change the
   Day 2
5. How can we test whether or not these variables will change the results?
   Day 3
6. What happened when we changed the temperature? Wind? Sunlight? Humidity? Surface area?
7. What combinations cause the fastest drying? The slowest?

XII. **Extension**

1. Do a more thorough testing on each condition (testing a wider variety of temperatures, use a wind gauge and graph the results with varying wind speeds, do the investigation during different times of the year, etc.).
2. Test different liquids for their evaporation rates (compare alcohol, tap water and salt water).
3. Test different wicks (nylon, cotton, and wool).



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TEMP-RATE

I. **Topic Area**
Weather

II. **Introductory Statement**
Students will learn about daily changes in weather.

III. **Math Skills**
a. Measurement
b. Averaging
c. Graphing

Science Processes
a. Observing
b. Recording data
c. Interpreting data
d. Predicting

IV. **Key Question**
Where does weather information come from?

V. **Materials**
1 celsius thermometer
Student worksheets 12 and 13

VI. **Background Information**
Students will need to learn vocabulary words:
a. Weather - The atmospheric conditions at any place at a particular time.
b. Climate - The weather conditions of a place over a a period of time.
c. Meteorology - The science of weather and climate.
d. Meteorologist - Person skilled in and usually occupied with the science of weather and climate.

VII. **Management Suggestions**
1. This investigation accumulates data over a period of time. It can be adapted to accomodate your schedule. It can be used as a one day to as many days as you want investigation.
2. Students will be reading a thermometer. It is best to choose small groups to take each reading. Make sure all students during the day get to participate.
3. The group reports the temperature to the class. Everybody must record it on the worksheet. You may want to keep a class record.
4. Thermometer should be placed outside in a
5. protected area where sun will not directly shine on it nor pick up too much reflected heat.
6. Thermometer should be placed in an area where it will not be disturbed by others.

VIII. **Procedure**
1. Teacher should mount thermometer.
2. Prepare wall chart if wanted. (Copy and enlarge student worksheet.)
3. Choose groups of students for temperature readings.

X. **What the Students Will Do**
1. Read thermometer.
2. Record temperature.
3. Figure averages.
4. Graph results.

XI. **Discussion**
1. Why did the temperature change?
2. Do day-to-day weather conditions have any effect on the temperature?
3. How accurate are meteorologists?
4. How does wind affect temperature?

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Every Breath You Take

I. **Topic Area**
Ecology

II. **Introductory Statement**
Each year over 330 million (330,000,000) tons of air pollution is put into our air.

III. **Math Skills**
a. Estimating
b. Weighing
c. Multiplying

Science Processes
a Observing
b. Generalizing

IV. **Materials**
Student Worksheet, page 14
White athletic sock (optional)
Large clear plastic garbage bag
Rubber bands
Automobile

V. **Key Question**
How much air pollution do you think a car produces in one minute?

VI. **Background Information**
Each year 165,000,000 tons of air pollution is produced in the United States and deposited in our atmosphere. On a worldwide basis 331,000,000 tons of pollutants are put into the air each year. 65% of this pollution comes from automobiles. Other sources plants, and to a lesser degree, household heating, cooking, and burning trash.

Four-fifths of all air pollution is invisible. Most of it is odorless. Burning gasoline in automobiles produces carbon monoxide (a deadly poisonous gas), benzypyrene (a cancer-causing agent), nitrogen oxide (a cause of chronic lung disease), and lead. Burning coal from industry and power plants adds sulfur dioxide to the air.

Besides being unhealthy, air pollution is expensive. Air pollution costs Americans about $16 billion each year in sickness, lost work time, extra laundry and drycleaning charges, damage to vegetation, crops, and livestock, damage to homes, buildings, car finishes and other materials, and lowered real estate values.

So what can we do to help? Walk, or ride a bike on short trips, organize car pools, use public transportation, keep our cars tuned up and running properly, drive smaller cars, recycle cans, bottles, and newspapers, turn off lights when not using them, and support clean air legislation. By caring, we can all breathe a little easier.

VII. **Management Suggestions**
Estimated time for investigation is about 20 minutes. You will want to allow more time for discussion.

VIII. **Procedure**
1. Ask key question.
2. Weigh empty garbage bag.
3. Attach empty garbage bag to exhaust pipe of car with heavy rubber band. Wrap some cloth around tailpipe prior to attachment to prevent bag from melting.
4. Start car and time how long it takes to fill bag with exhaust. A clear bag is dramatic, as children can actually see the pollutants.

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X. **What the Students Will Do**

1. Subtract weight of empty bag from weight of pollutant-filled bag to determine weight of pollutants.
2. Divide time needed to fill bag into 60 seconds, then multiply times weight of pollutants to determine rate of pollutants produced per minute.
3. Count how many cars pass in one minute.
4. Multiply number of cars per minute times weight of pollutants produced in one minute.
5. Multiply by 60 to determine weight of pollutants per hour.
6. Multiply by 24 for pollutants per day.
7. Multiply by 365 for pollutants per year.
8. Convert grams to pounds by multiplying grams by .0022.

XI. **Discussion**

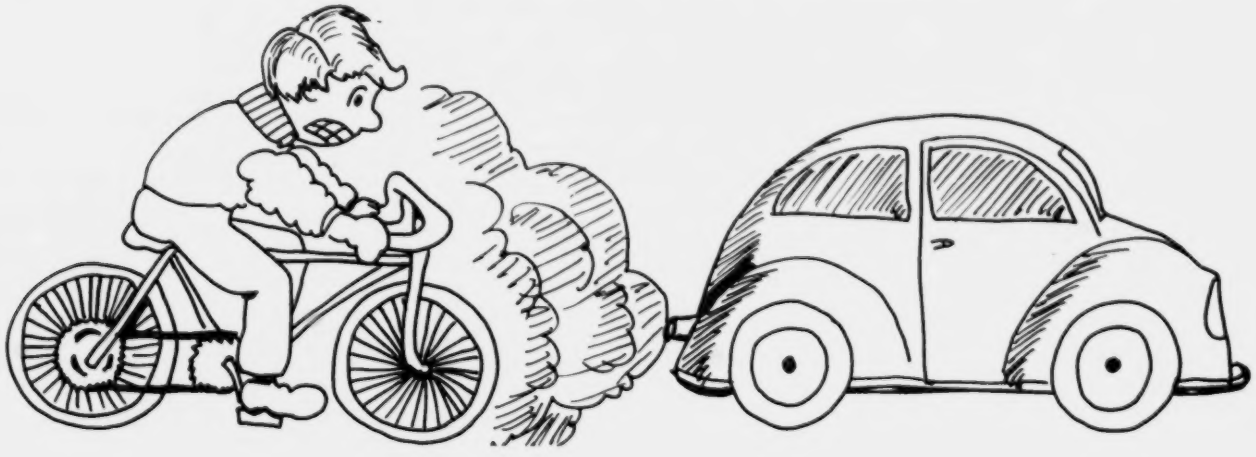
1. What was produced in the bag?
2. What effect did seeing the pollution have on you? How did you feel? What effect did weighing it have on your attitudes?
3. How does this pollution affect our health? Our property?
4. What can we do about air pollution?

XII. **Extension**

1. Brainstorm for pollution solutions.
2. Write letters to government officials concerning air pollution.
3. Make pollution traps from cotton balls or waxed paper or heavy paper coated with Vaseline and place around the school or community.
4. Role play a problem-solving situation with students acting as representatives of the automobile industry, motorists, environmentalists, physicians, and government.
5. Attach a white athletic sock to the car exhaust pipe with a rubber band and allow the car to run for a specific length of time. Compare this demonstration with the results of the garbage bag investigation.

XIII. **Curriculum Coordinates**

1. Health - research the effects of air pollution on health.
2. Language - write letters to government and industry; debate the issue of air pollution.
3. Social Studies - design a community where there would be no need for automobiles; conduct a community air pollution survey.



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SUBMERGED ISLAND

I. **Topic Area**

Topographical mapping

II. **Introductory Statement**

Students will be able to create a two-dimensional contoured map from an underwater three-dimensional model.

III. **Math Skills**

a. Estimating
b. Interpolating
c. Graphing

Science Processes

a. Measuring
b. Estimating
c. Predicting
d. Recording data
e. Interpreting data

IV. **Materials**

Aquarium (if not available, use a cardboard box without water)
Model of submerged island (clay, styrofoam, wood, rocks)
Prober (a "Mark Twain" made of small dowel, paint brush, coat hanger)
2 cm squared graph paper
Food coloring or water colors
Florist's putty
Ruler
Student Worksheet, page 15

V. **Key Question**

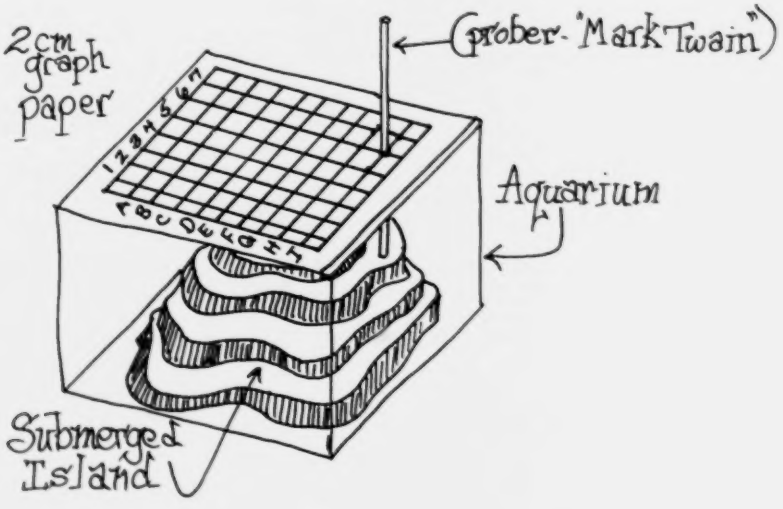
How do we know what the bottom of a lake looks like?

VI. **Background Information**

1. A "Mark Twain" method of probing will be utilized to discover the shape of the submerged island. The map will be created without actually seeing the submerged or covered three-dimensional model. Connecting like elevations will develop contour lines to give a picture of the submerged island.
2. There is a constant elevation or depth between contour lines, i.e., 20, 40, 60, 80.
3. A contour line represents a given elevation above (+) or below (-) sea level.

VII. **Management Suggestions**

1. This activity takes each student approximately thirty minutes of probing (Mark Twaining) at the aquarium. Therefore, the activity should be set up at the beginning of the week and the students assigned time slots to complete the probing and recording depths.
2. To add to the suspense, each student's contour map should be kept secret until everyone is finished and the aquarium is drained and the model is revealed.
3. In creating the model, choose layers of equal thickness (see illustration). This will make it easier for the students to draw the contours (Procedure 6).



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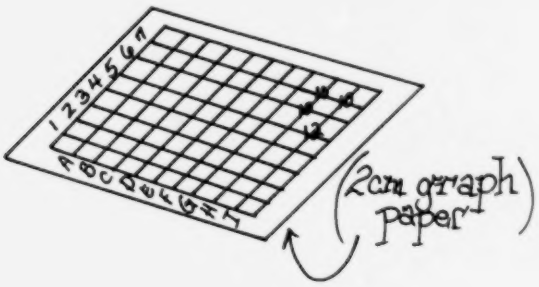
VIII. **Procedure**

1. Create a 2 cm grid for the top of the aquarium (see illustration). Plan to position your submerged island so that it will lie in the center of the grid; then label the grid markings to correspond with those of the student worksheet graph paper, or create a larger sheet of graph paper if your island is larger than those parameters.



2. Place the island model on the bottom of the aquarium and secure it in place with florist's putty.
3. Fill the aquarium, and add enough coloring to the water to obscure the island.
4. Measure the distance from the top of the aquarium to the water line (sea level). The student will subtract this distance from the total probing distance to give a below-sea-level reading. Place the grid on top of the aquarium.
5. Using the coordinates from the aquarium and the mapping grid, probe, measure, subtract, and record.
6. Connect all dots of equal depths (remember that contour lines run through like elevations) to develop the two-dimensional contour of the submerged island.
7. Unveil the three-dimensional submerged island. How closely do the students' two-dimensional maps compare? Lay out the slices of the three-dimensional model to find out.

X. **Discussion**

1. How do the maps compare?
2. Were some maps a more accurate representation of the submerged island than others?
3. Why were some maps more accurate?
4. How do you know if you are looking at a high or low spot?
5. How can you tell a valley from a ridge?

XI. **Extension**

1. How do we actually map the ocean floor? (See "Mapping the Ocean Floor," T. Manual page
2. What is the importance of mapping the world?
3. Examine some contour maps put out by the US Forestry Service and compare them with those of the class.

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Mapping The Ocean Floor

I. **Topic Area**

Oceanography - mapping the ocean floor

II. **Introductory Statement**

Upon completion of this activity, students will understand sonic depth sounding and be able to prepare a profile of underwater terrain using a model of this method.

III. **Math Skills**

a. Graphing
b. Using decimals
c. Averaging

Science Processes

a. Predicting
b. Comparing
c. Collecting data
d. Drawing conclusions

IV. **Materials**

Each group will need:
Student Worksheets, pages 16 and 17
1 large clear water container (liter cube, quart jar)
1 penny
1 rubber band
1 thumbtack
1 plastic bag fastener
1 paper clip
1 stop watch

V. **Key Question**

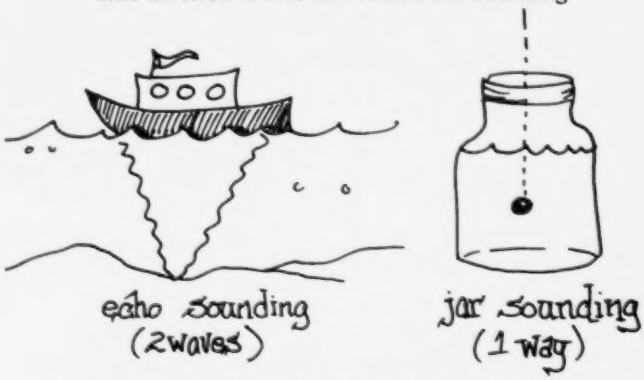
How do we know what the ocean floor looks like?

VI. **Background Information**

1. Vocabulary: fathom, profile, sonar (sounding), sloping shelves, plateaus, continental shelves, trenches.
2. Sonic depth recorders are used for determining the profile of the ocean's floor. They send out powerful sound waves from a ship's hull. These sound waves are reflected from the ocean bottom to the ship. On the ship, they are picked up by a sonar receiver. The deeper the ocean, the longer the time required for the echo to return to the sonar receiver. Sound waves travel through salt water at a rate of 1524 meters/second. Depth is determined by using the formula $D = \frac{1}{2} T \times V$.

VII. **Management Suggestions**

1. Time schedule:
   Day 1: Discuss key question, present vocabulary, plan procedure.
   Day 2: Do the activity.
   Day 3: Do the graphing and charting.
2. Mapping is based on echo sounding, that is, to the ocean floor and back. In this investigation students must remember that the objects that they are using only go down, NOT back up again. Therefore, the time involved is one half of an echo sounding.



3. Practice dropping objects before beginning the investigation.
4. Break the surface tension of the water before dropping the objects.

VIII. **Procedure**

1. Divide students into small groups (2-5) and distribute the necessary materials.
2. The students should fill the jars with water and drop each object five times into the water, timing and recording each drop.
3. Average the data and graph the results.
4. Color the graph to represent the ocean water and ocean floor.

X. **Discussion**

1. How do we know what ocean floors look like?
2. Why map the ocean floor?
3. What do you learn by studying the ocean's profile?
4. Would the difference in bouyancy affect the outcome?

XI. **Extension**

1. Find a local pond of water (shallow) and allow students to plot, graph, and determine the pond's profile.
2. Some students may develop their own investigations using other variables. (What would happen if I used...?)

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I. Topic Area

Relationship of ice to water.

II. Introductory Statement

Upon completion of this investigation, students will have an understanding of why ice floats.

III. Math Skills

a. Graphing
b. Applying procedures
c. Weighing
d. Measuring

Science Processes

a. Recording data
b. Interpreting data

IV. Materials

Each group will need:
Student Worksheets, pages 18 and 19
8 small containers (up to 200 ml)
1 scale with weights
1 graduated cylinder
Water
Access to a freezer

V. Key Question

Why does ice float? What is the density of an ice cube?

VI. Background Information

1. This is a good investigation to use so that students will understand that 1 ml of water weighs 1 gm.
2. An iceberg is a great chunk of ice that has broken off of a glacier (continental ice sheet).
3. Icebergs in the North Atlantic are irregularly shaped and are sharply crested. They are thousands of feet wide, equally as long, and hundreds of feet thick.
4. In Antarctica, icebergs tend to have a flat surface. A single iceberg in Antarctica can cover an area of several miles and may have a thickness of 2,000 feet or more.
5. Ice floats because the density is less than that of liquid water. The difference is so slight that almost all of a floating block of ice is below the water line. About 5/6 is submerged.
6. Water expands when frozen. Air is added.
7. Density is a measure of mass per unit volume. It is defined by the formula D = M/V.
8. When mass is measured in grams and volume in cubic centimeters, density is expressed in grams per cubic centimeter. It can also be thought of as the ratio of mass to volume.
9. Fresh water at 4° Celsius has a density of 1 gram per cubic centimeter. An object with a lesser density will sink at that temperature.

VII. Management Suggestions

1. Timeline:
   Day 1 - present background information and plan procedure.
   Day 2 - do investigation. Start early in the morning so that you can finish later in the day.
2. Water (ice) should be weighed as soon as possible after freezing.

VIII. Procedure

1. Divide class into small groups (2-3).
2. Each group will weigh containers and record weight on the container and on the record sheet.
3. Fill 8 containers with different amounts of water: 25, 50, 75, 100, 125, 150, 175, and 200 ml.
4. Check weight of water and container combined.
5. Freeze water.
6. Weigh frozen water in container.
7. Record weight on record sheet.
8. Figure difference.
9. Graph results.

X. Discussion

1. Does ice float? Why?
2. Does an amount of water when frozen weigh the same as when liquid?
3. What kind of water are icebergs made of?

XI. Extension

1. This investigation can go beyond the limits set here. Any amount of water can be tested.
2. Use a graduated cylinder and float an ice cube. Determine the displacement of water.
3. Find out about the freezing of salt water, etc.

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When Polar Ice Caps Melt

I. Topic Area

Polar ice caps and sea level

II. Introductory Statement

Polar ice caps hold two percent of the available fresh water. If they melted, the coasts of all countries would become flooded.

III. Math Skills

a. Calculating volume
b. Calculating area
c. Measuring
d. Dividing

Science Processes

a. Predicting
b. Estimating
c. Recording data
d. Interpreting data

IV. Materials

Student Worksheets, pages 20 and 21
Large flat pan
Sand and pebbles
Block of ice
Ruler (mm)

V. Key Question

If polar ice caps melt, what would happen to the rest of the world?

VI. Background Information

1. Polar ice caps hold two percent of the available fresh water in the world.
2. Water locked up in the Antarctic ice cap alone equals approximately 17,900,000 km^2. The area of the earth covered by water equals approximately 358,000,000 km^2.
3. If the Antarctic ice cap melted, the rise in sea level around the world could be computed by the following formula:

$$\frac{\text{Vol. } H^2O \text{ in Ant. ice}}{\text{Area covered with } H^2O} = \frac{17{,}900{,}000\ km^3}{358{,}000{,}000\ km^2}$$

The water would rise approximately 50 meters.

4. The same formula as above can be used with this investigation by substituting:

$$\frac{\text{Vol. } H^2O \text{ in Ant. ice}}{\text{Area earth covered w/} H^2O} = \frac{\text{Vol. } H^2O \text{ in ice block}}{\text{Area pan covered w/} H^2O} = \text{rise in sea level.}$$

VII. Management Suggestions

1. Two days before the investigation, freeze the ice blocks and gather enough sand and pebbles to fill half of the pan.
2. You may use one large model for the entire class or several smaller models for group activity.
3. Depending on the volume of the ice block and the temperature of the air, you can plan one or two days for complete meltdown of the ice block. Allow two 45-minute class periods for project completion.
4. An occasional observation throughout the meltdown time is advisable. Students may observe and record their findings.

VIII. Procedure

1. On the first day, measure and record the volume of the ice block, the water surface area, and the water depth.
2. Then follow the directions throughout the student worksheets.

X. Discussion

1. In what way is this model similar to what happens on earth?
2. What kinds of errors occur when any model is used?

XI. Extension

1. Using clay, make a scale model of a known coastal area. Fill the pan with water to existing sea level. Support an ice block off shore on some sand and pebbles. Observe the melting of the ice cap and its influence on the coastal region.
2. Calculate the rise in sea level in the event of a total polar ice cap meltdown. What would be the effect on the coastal countries?
3. Some scientists say the earth is heating up. Some say it's cooling off. Research the theories and discuss some possible conclusions.

SALTY CHANGE

I. Topic Area

Determining how the boiling and freezing temperatures of water are affected by the addition of a solute.

II. Introductory Statement

Upon completion of this activity students will be able to explain how salt as a solute will affect boiling and freezing temperatures of water.

III. Math Skills

a. Graphing
b. Reading temperatures
c. Estimating

Science Processes

a. Stating a problem
b. Collecting data
c. Predicting
d. Making comparisons
e. Interpreting data
f. Drawing conclusions

IV. Materials

Each group will need:

Alcohol burner or other heat source
Watch or clock with sweep second hand
Student Worksheets, pages 22-24
50 ml beaker
Thermometer
Table salt
Graduated cylinder
Wire gauze
Styrofoam cup
Support for thermometer
Ring stand
Teaspoon
Ice cubes
Support for beaker
Alcohol 91% isopropyl

V. Key Question

What happens to boiling and freezing water when we add salt?

VI. Background Information

Vocabulary: solute, line graph

VII. Management Suggestions

1. Remind students to keep the thermometers from touching the bottom of the container.
2. Remind students to be very accurate in their work.
3. See student worksheet page 22 for an illustration of the beaker/thermometer arrangement.
4. Timeline:
   a. One 40-minute period for preparation and introduction to the activity.
   b. Two 40-minute periods for the actual activity.

VIII. Procedure

1. Divide students into groups of 3-5 and distribute the necessary materials.
2. Follow the directions on the student worksheets.

X. Discussion

1. What effect did the addition of salt have on the boiling point of water.
2. What effect did the addition of salt have on the temperature of the ice water?
3. What is the lowest temperature reached by the ice water? The highest temperature reached by the boiling water?
4. What effect did adding salt to the water have on the rate of temperature change?
5. What effect did adding salt to the water have on its boiling point?

XI. Extension

1. Observe the rate of temperature change as the water returns to room temperature.
2. Do the same investigation using sugar instead of salt.
3. How would the addition of other substances affect the outcome of this investigation?
4. In what other ways could you set up this investigation?
5. How could you apply what you have observed in this investigation to your daily life?

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WHAT ON EARTH WE DO?

I. **Topic Area**
Ecology

II. **Introductory Statement**
When man "develops" land there is an impact on wildlife, soil, water, and air.

III. **Math Skills**
a. Estimating
b. Weighing
c. Measuring

Science Processes
a. Sorting
b. Classifying
c. Observing
d. Generalizing

IV. **Materials**
Student Worksheet, page 25
Soil core samples (1 per student)
Metric rulers
Metric scales

V. **Key Question**
If you had some land, what would you do with it?

VI. **Background Information**
When man changes a piece of the natural landscape, he affects many different things. The contours of the land are changed, thus changing water runoff patterns and causing soil erosion. When land is paved or covered with buildings, runoff is increased and there is less exposed soil surface. Water can no longer soak into the ground, thus lowering the water table. Removal of plant cover removes soil protection, increasing erosion and destroying wildlife habitat. Factories and automobiles add to air pollution problems. Services such as sewage, water, police and fire protection are hidden costs that are passed on to the taxpayer. In the words of John Muir, "When we try to pick out anything by itself we find it hitched to everything in the universe." All of the consequences should be considered before we use our precious land resources.

VII. **Management Suggestions**
Estimated time is 45 minutes. The teacher will need to prepare core samples of soil. This can be done by cutting both ends out of empty food cans and pushing, twisting, or gently hammering them into soft, moist soil. Each student should have his/her own core sample.

Be sure students take their core samples apart slowly and carefully and sort the contents into categories. Students may share scales and rulers. Cover tables or desks with newspaper for easy cleanup.

VIII. **What the Students Will Do**
1. Estimate the weight of the core sample.
2. Weigh and record sample (in can).
3. Gently push soil from can.
4. Weigh and record weight of can.
5. Subtract weight of can from weight of can with soil to get weight of soil sample. Record.
6. Slowly and carefully take the soil sample apart, sorting what they find into categories of their own choice.
7. Try to put the soil core sample back together exactly the way they got it.

X. **Discussion**
1. What did you find in your soil sample?
2. What categories did you put your findings in?
3. Could you put it back together?
4. You used your hands to take a piece of the earth apart. When people "develop" land what kind of equipment do they use?
5. How is the land changed? What is affected?
6. Can they put it back together the way nature created it? Why not?
7. What is meant by environmental impact?

XI. **Extension**
1. Prepare an environmental impact report on a local development. Consider what it was like naturally, what it is like now, and the development's effects on wildlife, habitat, soil, water, erosion, water table, agriculture, added services, taxes, people, and the quality of life. What was lost? What was gained? What are the real costs?

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2. Research proposed developments. What are the gains? Losses? What is the real cost? Are the gains worth the losses?
3. Have a speaker from the city planning department speak to the class.
4. Study the city plan. Investigate zoning and land use. Make recommendations to the city planning department.
5. Write letters to government officials about land use and environmental issues.
6. Plan a community that is in harmony with the environment. This community plan can be done by groups working on large pieces of butcher paper.
7. Design an ecologically sound home.

XII. Curriculum Coordinates

1. Language Arts
   a. Write letters on environmental issues.
   b. Look for newspaper articles on land use.
   c. Have a class "town forum" on land issues.
   d. Debate land use issues and topics.

2. Social Studies
   a. Research and report on the history of land use in the community.
   b. Prepare a land use plan for the community.

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The Sands of Time

I. Topic Area

Sedimentary rock.

II. Introductory Statement

Upon completion of this activity, students will be able to classify sand particles.

III. Math Skills

a. Using place value
b. Using decimals
c. Finding percentage
d. Averaging
e. Graphing

Science Processes

a. Predicting
b. Comparing
c. Collecting data
d. Drawing conclusions

IV. Materials

30-40 grams coarse-grained sand for each group
1 hand lens for each student
1 magnet for each group
Tweezers (optional)
Toothpicks (optional)
Colored pencils
Student Worksheets, pages 27-29

V. Key Question

What is the composition of sand?

VI. Background Information

1. Vocabulary: quartz, silicon, biotite mica, muscovite mica, pyrite, feldspar, weathering, sediment, iron, hornblende, calcite.
2. Sedimentary rock is composed of small mineral particles which have been deposited in the ocean by wind, flowing water, and other natural forces. This sediment settles to the ocean floor and forms into layers or beds.

VII. Management Suggestions

1. Timeline:

   a. Two or three 45-minute preparatory periods.
   b. One 60-minute period for the actual activity.
   c. One 60-minute period for making the percentage chart and the graph.

2. For the actual experiment, divide the class into groups of 2-6 students.
3. Experiment with classifying several samples of sand.
4. Work with the students to be certain that they are having success in identifying the sand particles.
5. List the names and colors of different minerals found in the sand on the chalkboard. (Consult the encyclopedia for positive identification.) Examples:
   a. Biotite mica - brown to black
   b. Quartz - colorless or of varying colors
   c. Feldspar (orthoclase) - white to gray, red
   d. Iron - black
   e. Pyrite - light brassy yellow
   f. Muscovite mica - white to light gray or clear
   g. Hornblende - green to black
   h. Calcite - white (pure) to varied (impure)

VIII. Procedure

1. Divide class into groups and distrubute materials.
2. Mark off a 1 cm or 2 cm square area on the 2.5 cm graph paper (student worksheet, page 29).
3. Spread 30-40 grams of coarse-grained sand in a single layer.
4. Note the area of graph paper covered by the sand.
5. Remove the sand from the marked area of graph paper and using the tweezers and toothpicks sort it by size and color. View the samples with the hand lens. Classify according to mineral type.
6. Count the number of grains of each type and record in one corner of the appropriate boxes in the column for your sample. Gather data from the other members of your group and record in the other columns of your paper.
7. Using your count for each mineral and the total number of grains in your sample, compute the percentage of each mineral and record in the same boxes in your column. (This can be done on the following day.)
8. Total the samples in each row, note the number of samples of each, and average. Compute the percent of each average.
9. Graph the results.

X. Discussion

1. How many minerals can you identify?
2. Why is it important to know the composition of sand?
3. What do we use sand for?

XI. Extension

1. Using the average percentages, compute the weight of each mineral that one would expect to find in a kilo of this sand. In a ton. In a truck load.
2. List five minerals that are important in industry as gems. How are they used?
3. How are solar cells made?

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THE WATER WORKS

including
SHOOT THE RAPIDS, FLOOD STAGE, & QUICK SAND

I. **Topic Area**

The interrelationship of the slope of a stream and the volume of water flowing, and their effects on the size of particles being moved in a stream.

II. **Introductory Statement**

This set of three investigations is written so that they may be used separately or as a unit. "Shoot the Rapids" and "Flood Stage" develop an understanding of variables and their effects on erosion. "Quick Sand" allows the student the opportunity to apply the concepts learned by hypothesizing and controlling variables.

These investigations have the same basic equipment and set up. Common features are listed here, and specific differences for each investigation are listed under their separate titles.

III. **Math Skills**

a. Computing rates
b. Measuring length, volume, angles
c. Averaging
d. Coordinate graphing

Science Processes

a. Recording data
b. Controlling variables
c. Interpreting data

IV. **Materials**

Each group will need:

1 trough (5 ft of $\frac{1}{2}$-round plastic rain gutter — available at most hardware stores)
4 3-ft lengths of surgical or rubber tubing ($\frac{1}{4}$" i.d.)
2 supports (bricks, books,boxes, et al.)
4 clothespins
3 buckets
Meter stick
Protractor (or clinometer)
1 weight (nut or stone)
5 rubber bands
Toothpicks
Stop watch
String
Sand

V. **Key Question**

Why can the Colorado River erode such a deep gorge like the Grand Canyon while the Mississippi River flows across a flat plain nearly level with the land around it?

VI. **Background Information**

Rate of erosion is the result of the interrelationship of the volume and the velocity of water in the stream bed.

The Colorado River has an average flow of 18,240 cubic feet per second, while the Mississippi has an average flow of 559,300 second/feet. The Colorado is able to carry large particles and erode deeply because of its velocity, which is due to its rapid descent. The Mississippi, on the other hand, descends less than one foot per mile. It neither cuts very deeply into the area around it nor carries large particles. However, its sheer volume allows it to carry a phenomenal amount of silt.

VII. **Management Suggestions**

1. Allow 9-12 days; 3-4 for each investigation.
2. A constant water supply is needed.
3. These activities are best done outside or where spills can be cleaned up easily.
4. Students need to maintain constant pressure on syphons by keeping the top bucket filled to the same level. This can be done two ways:

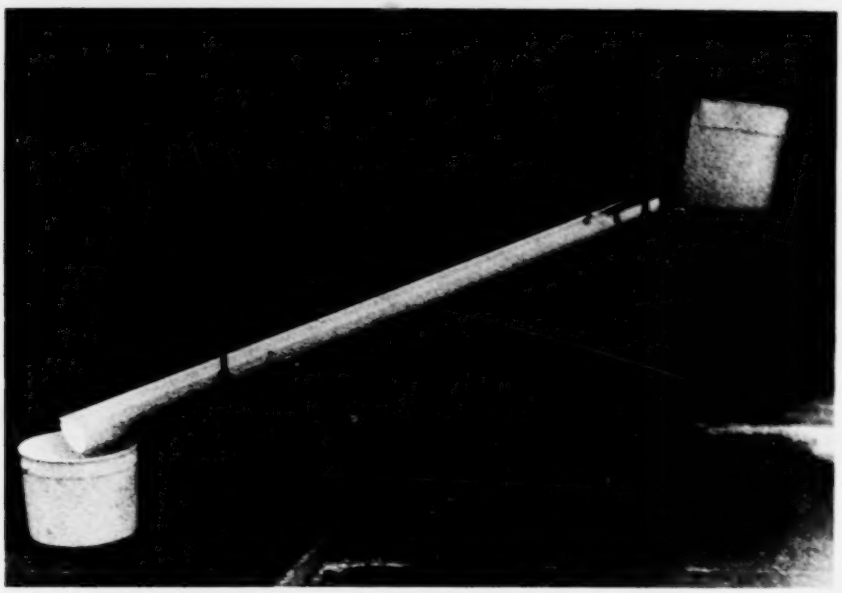
   a. If water can be drained on the ground, students need only keep filling the top bucket.
   b. If water cannot be drained at the bottom, it can be recycled by exchanging the lower bucket with a third bucket. Then the bottom bucket can be emptied into the top bucket. In this way very little water is lost.

5. Students need to have a good idea of rates. This is a useful and frequent use of ratios. Without this background, students will not gain a clear understanding of the experimental results.

VIII. **Procedure**

1. Divide students into groups of at least five. Assign roles: timing, controlling water flow, maintaining water supply, releasing toothpick, recording.
2. Distribute necessary materials to each group.
3. Set up basic equipment:

   a. Connect 4 surgical hoses together with rubber bands.
   b. Place a clothespin near the same end of each hose.
   c. Set up supports, trough, and buckets as shown:
   d. Place end of hoses without clothespins into water in top bucket.
   e. Syphon water through hoses and use clothespins as valves to hold water in hose.
   f. Assemble a clinometer by tying string to weight and taping string to clinometer.



SHOOT THE RAPIDS

I. **Topic Area**

The effect of a stream's slope on its velocity.

II. **Introductory Statement**

Upon the completion of this activity, students will be able to determine the velocity of a stream and describe the relationship between slope and velocity.

IV. **Materials**

Student Worksheets, pages 30 and 31
Supplies per "The Water Works"

V. **Key Question**

How fast are you moving when you float down a river?

VI. **Management Suggestions**

Timetable: one 45-minute preparation period, one 45-minute period for the actual activity, and one 45-minute period for graphing and interpretation.

VIII. **Procedure**

1. Set up basic equipment from "The Water Works."
2. Make a mark 25 cm from the top end of the trough. This will be the starting line.
3. Measure and record the distance from the starting line to the far end of the trough.
4. Set the slope of the trough at 5°.
5. Open all four syphons and maintain a constant flow.
6. For 5 trials use a stopwatch and time a toothpick floating from the starting line to the bottom of the trough. Record these times.
7. Repeat the experiment for the slopes of 10°, 15°, 20°, and 25°.
8. Compile the results and graph the data.

X. **Discussion**

1. Did the water velocity increase at the same rate throughout the activity? Why? Why not?
2. How does the slope of a stream affect its flow?

XI. **Extension**

Determine the velocity of other objects.

FLOOD STAGE

I. **Topic Area**

The effect of a stream's volume on its velocity.

II. **Introductory Statement**

Upon the completion of this activity, students will be able to describe the relationship of the volume of water in a stream and its velocity, and determine the rate of flow in a stream.

IV. **Materials**

Student Worksheets, pages 32 and 33
Supplies per "The Water Works"

V. **Key Question**

Do you float faster on a river when it's at flood stage?

VII. **Management Suggestions**

Timetable: one 45-minute preparation period, one 45-minute activity period, and one 45-minute period for graphing and interpretation.

VIII. **Procedure**

1. Set up basic equipment as in "The Water Works."
2. Make a mark 25 cm from the top end of the trough for the starting line. Measure and record the distance from the starting line to the far end of the trough.
3. Set the slope of the trough at 10°.
4. Set the volume measure at the low end of the trough.
5. Open one syphon and obtain a constant flow.
6. Time and record how long it takes to collect 200 ml of water.
7. Using a stopwatch, for five trials time and record a toothpick floating from the starting line to the bottom of the trough.
8. Repeat these steps with 2, 3, and 4 tubes.
9. Compile the results and graph the data.

X. **Discussion**

1. Did the volume of water in the stream affect the velocity of the stream? Why? Why not?
2. Why would you expect a flooding river to do more damage than a normally-flowing river?

XI. **Extension**

See if the mass of other objects affects their velocity. For example, roll various marbles and balls down the trough.

Quick Sand

I. **Topic Area**

Effects of a stream's slope and rate of flow on its rate of erosion.

II. **Introductory Statement**

Upon the completion of this activity, students will be able to state the relationship between a stream's slope and rate of flow and the rate of erosion.

IV. **Materials**

Student Worksheets, pages 34 and 35
Supplies per "The Water Works."

V. **Key Question**

Can a smaller river erode more soil and rocks than a larger river?

VII. **Management Suggestions**

1. Timetable: one 45-minute preparation period, one 45-minute period for the slope activity, and one 45-minute period for volume activity, and one 45-minute period for graphing and interpretation.
2. Students' graphs on both parts of the experiment will drop off rapidly initially and then level out. This is opposite of the graphs of "Shoot the Rapids" and "Flood Stage." This is because in "Quick Sand" the verticle axis is not a rate. The information on the three graphs is similar, but appears very different. Students may need some help to understand this.

VIII. **Procedure**

Part 1

1. Set up the basic equipment from "The Water Works."
2. Set the slope of the trough at 5 °
3. Open 2 syphons and maintain a constant flow.
4. Place 50 ml of sand in the middle of the trough. Time and record for five trials how long it takes to erode all the sand. At smaller slopes the trough may be rocked slightly to help in washing all the sand down.
5. Repeat for the other slope settings.
6. At this point there is a natural break. If the period is not long enough to complete the whole activity, stop here the first day and continue later.

Part 2

7. Set the trough back to a slope of 10 ° (this will not change throughout the rest of the experiment).
8. Set the volume measure at the low end of the trough.
9. Open one hose and obtain a constant flow.
10. Time and record how long it takes to collect 200 ml of water.
11. Place 50 ml of sand in the middle of the trough. Time and record for five trials how long it takes to erode all the sand.
12. Repeat the process for 2, 3, and 4 tubes.
13. Compile the results and graph the data.

X. **Discussion**

1. What are similarities and differences in the graphs?
2. Why are there differences?
3. Which stream could carry away the most sand?
4. In nature, could rates of flow and slope change at the same time?

XI. **Extension**

1. What would happen if you changed the rate and the slope at the same time?
2. Could you use this experiment to determine how much land a stream would erode? How could you stop the erosion? Can you test it?
3. Could you make a model of the Mississippi and Colorado Rivers and determine which erodes more?

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PROSPECTOR'S

I. Topic Area

Mining techniques, substances identification and separation, chemical and physical properties of substances, rock and hydrological cycles, and commercial cost effectiveness.

II. Introductory Statement

This unit of study uses a mining scenario to introduce the concepts of a cost effective commercial operation, physical properties of certain substances, techniques for separating substances in a mixture, and the rock and hydrological cycles.

III. Math Skills

a. Measuring mass
b. Using ratio, percent, and decimals
c. Keeping a time card
d. Keeping a balance sheet
e. Calculating a cost analysis
f. Comparing mathmatical results

Science Processes

a. Comparing data
b. Classifying data
c. Interpreting data
d. Applying and generalizing
e. Separating substances

IV. Materials

Student Worksheets, pages 36-43
Iron filings (available free at machine shops)
Sawdust (available free at lumber yards)
Small plastic bags
Paper cups
Sand
Scale
Magnets
Glass dishes
Heat source
Balance and gram weights
Plaster of Paris
Salt
Hammer
Paper coffee filters
Strainer
Small pan

V. Key Question

How does a company know if it is profitable to mine a certain area?

VI. Background Information

Before mining an area, a company does a survey of the area being considered. Core samples are drilled from the area and analyzed to see what amounts of the substances can be claimed. Using this information and the anticipated price the substance will bring, the company can estimate how much money will be made by the mine. By subtracting the mining costs from this sum, they can tell if the mine will make a profit.

Students will be allowed to extract substances from the "mountains" that they make in ways that they choose, but generally the most successful operations use the following method:

1. Scrape or extract areas of substances around veins and cleavages.
2. Pulverize this material.
3. Use a magnet to extract the iron.
4. Place remaining material in water. Remove floating sawdust.
5. Pour water through filter, which traps plaster and sand and allows dissolved salt through. Collect the water in a glass dish and evaporate to gather the salt.
6. Rinse the filter into a dish. Sand, being denser, will sink along with some of the plaster. Gently pour off the floating plaster through another filter. Add more water to the sand/plaster sediment remaining in the dish and repeat the floating/pouring process until all the plaster is floated off the sand.

VII. Management Suggestions

1. The intertwining of information and skills in this investigation creates an entire unit of study. Begin by studying the rock and hydrological cycles. Introduce the concept of a cost effectiveness study and create a general plan with the students for the process that they will be going through as miners to create their mountains and mine them, and keep records of expenses and income, and as evaluators.

2. Timetable of mining activities:
   Day 1 - make mountains (student page 36) and plan mining.
   Day 2-4 - mining takes place.
   Day 5 - weigh extracted substances and begin the evaluation process.
3. When making mountains, make the plaster thick. Too much water allows the sand to settle to the bottom and the other substances to mix to form a slurry rather than sticking together in veins.
4. Weighing the substances in small plastic bags simplifies the process a great deal.
5. Be sure that students cover the fragments with a paper towel while they are crushing them to protect their eyes.
6. Students will not mine the mountains that they build. Label the mountains so that it will be easy to keep track of who gets which.
7. Guide the students in creating a chart of properties and mining techniques for the substances they are using in their mountains. Example:
   a. NaCl (salt)
      Properties: white, granular, dissolves in water
      Mining: dissolve in water, filter, evaporate
   b. Fe (iron filings)
      Properties: black or rust, sinks in water, attracted by magnet
      Mining: collect with magnet
   c. Pulpwood (sawdust)
      Properties: beige, floats in water
      Mining: place in water, collect what floats
   d. Silica (sand)
      Properties: brown, granular, sinks in water
      Mining: place in water, collect what sinks
8. A piece of "gold" may be included in a few of the mountains as an incentive for careful mining.

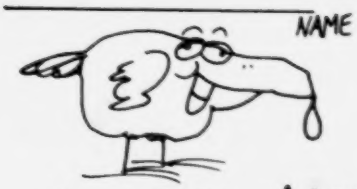
VIII. **Procedure**

1. Begin with the study proposed in Management Suggestions # 1.
2. Divide the students into groups of 3 or 4 and have them plan individual responsibilities for the mountain-making process.
3. While students are weighing the substances for their mountains and mixing them together, mix the plaster. Make the mountains according to the instructions on student worksheet page 36.
4. Have each group plan their mining process and requisition the mining equipment they will need. Record on student page 39.
5. Do the mining, separating the substances and measuring the mass of each, and record on student page 39 the data as well as the amount of time worked.
6. Complete the prospector's report, student page 39.
7. Complete the evaluation process, student pages 40-41.

X. **Extension**

1. Make cost effectiveness studies of other activities to see whether or not they are profitable.
2. Find some natural ore or other material and find out how to extract substances from it. Could it be done profitably?
3. Research the role of mining in our economy and society.
4. Use other materials to see if they can be recovered.
5. Try other mining techniques, such as gold panning.

Dripping Wet



Thermometer Readings = STATIONS =

DAY #1

DATE

TIME

	1	2	3	4	5	6	TOTAL	AVERAGE
WET BULB								
DRY BULB								
% RELATIVE HUMIDITY								

DAY #2

DATE

TIME

	1	2	3	4	5	6	TOTAL	AVERAGE
WET BULB								
DRY BULB								
% RELATIVE HUMIDITY								

DAY #3

DATE

TIME

	1	2	3	4	5	6	TOTAL	AVERAGE
WET BULB								
DRY BULB								
% RELATIVE HUMIDITY								

DAY #4

DATE

TIME

	1	2	3	4	5	6	TOTAL	AVERAGE
WET BULB								
DRY BULB								
% RELATIVE HUMIDITY								

DAY #5

DATE

TIME

	1	2	3	4	5	6	TOTAL	AVERAGE
WET BULB								
DRY BULB								
% RELATIVE HUMIDITY								

Dripping Wet

Name

Relative Humidity (Per Cent)

Difference in Wet Bulb and Dry Bulb Readings (°F)

Air Temperature (°F)	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	15°	20°	25°	30°	35°
20°	85	70	55	40	26	12									
25°	87	74	62	49	37	25	13	1							
30°	89	78	67	56	46	36	26	16	6						
35°	91	81	72	63	54	45	36	27	19	10					
40°	92	83	75	68	60	52	45	37	29	22					
45°	93	86	78	71	64	57	51	44	38	31					
50°	93	87	80	74	67	61	55	49	43	38	10				
55°	94	88	82	76	70	65	59	54	49	43	19				
60°	94	89	83	78	73	68	63	58	53	48	26	5			
65°	95	90	85	80	75	70	66	61	56	52	31	12			
70°	95	90	86	81	77	72	68	64	59	55	36	19	3		
75°	96	91	86	82	78	74	70	66	62	58	40	24	9		
80°	96	91	87	83	79	75	72	68	64	61	44	29	15	3	
85°	96	92	88	84	80	76	73	69	66	62	46	32	20	8	
90°	96	92	89	85	81	78	74	71	68	65	49	36	24	13	3
95°	96	93	89	85	82	79	75	72	69	66	51	38	27	17	7
100°	96	93	89	86	83	80	77	73	70	68	54	41	30	21	12
105°	97	93	90	86	83	80	77	74	70	69	55	43	33	23	15
110°	97	93	90	87	84	8	78	75	73	70	57	46	36	26	18
115°	97	94	91	88	85	82	79	76	74	71	58	47	37	28	21

Name _____

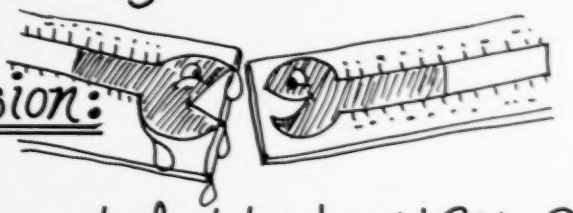
Dripping Wet

Relative Humidity

Please use a graph to show the daily average of relative humidity for stations 1-6.

	Stations	0 10 20 30 40 50 60 70 80 90 100
Day 1	1-6	
Day 2	1-6	
Day 3	1-6	
Day 4	1-6	
Day 5	1-6	
AVERAGE	1-6	

Average per cent of relative humidity at all stations: _____



Questions for Discussion:

1. Which 3 stations have the highest per cent of relative humidity? Why?

_____

_____

2. Which 3 stations have the lowest per cent of relative humidity? Why?

_____

_____

3. Using all the information collected, which station had the highest per cent of relative humidity? Why? _____

_____

_____

4. Using all the information collected, which station had the lowest per cent of relative humidity? Why? _____

_____

_____

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Name _____

Dripping Wet

Relative Humidity

5. Name at least 2 good reasons why we need a low per cent of relative humidity in an agricultural area. _____

6. Name at least 3 factors that may change the average per cent of relative humidity. _____

7. Explain how the time of day would affect your decisions regarding the questions you have answered. _____

8. If you were to state a problem related to this investigation, how would you state it? _____

9. Do you think you could have estimated the per cent of relative humidity at each station. If so, what factors would you use? _____

10. If given an opportunity to change this investigation, in what ways would you change it? _____

11. Using the bar graph, do you recognize any problem with morning classes compared to afternoon classes regarding the amount of moisture in the air? If so, what has happened? _____

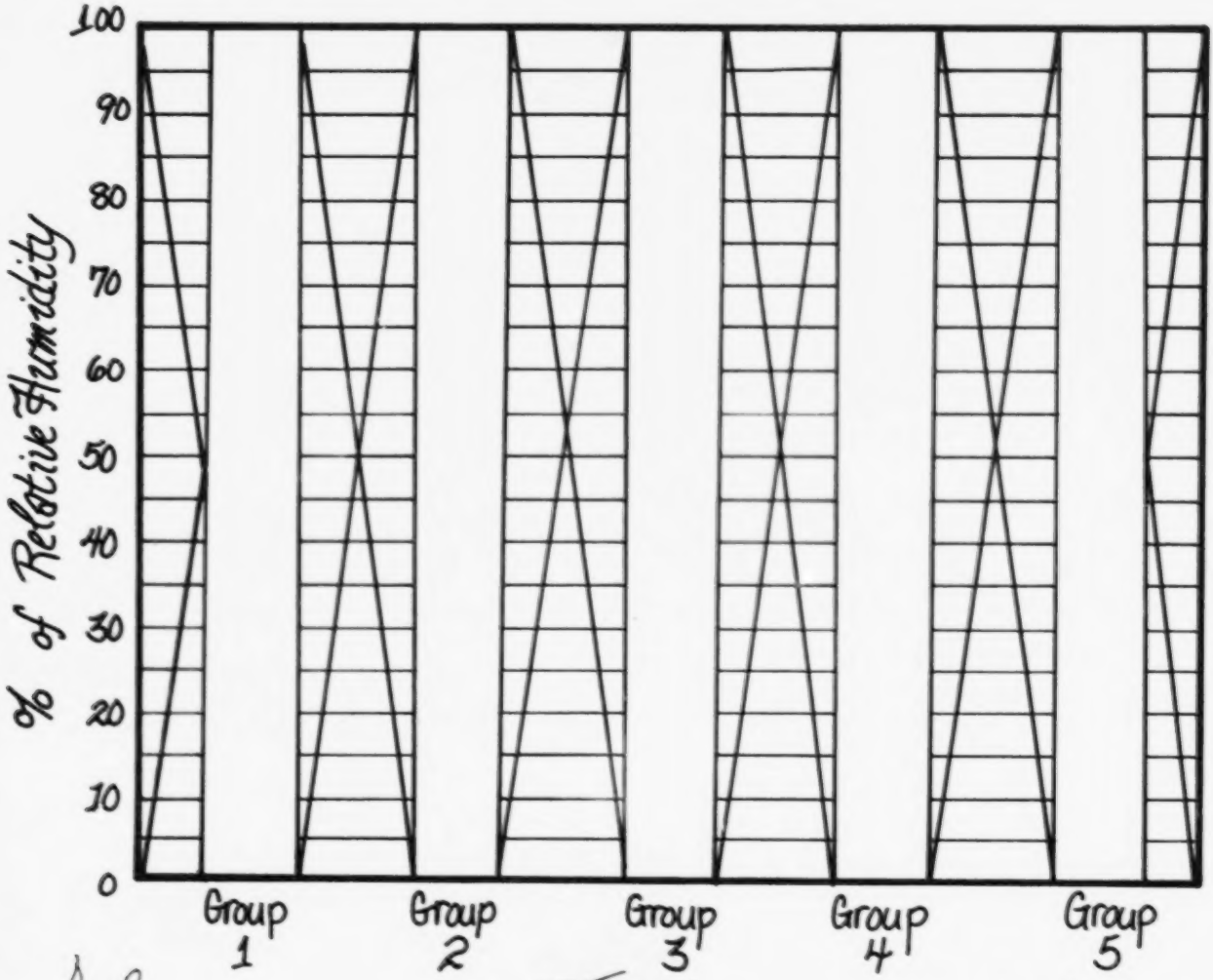
Dripping Wet

Name _____

Relative Humidity

Group Comparisons Bar Graph

Use average percent of relative humidity for five days at all weather stations.



NAME _____

When You're Hot, You're Hot !

Which would obtain the higher temperature, a black container of water or a white container of water?

Temperature Readings

Time	Day 1		Day 2		Day 3		Day 4		Day 5	
	Black	White	Black	White	Black	White	Black	White	Black	White
9										
12										
3										
Weather Conditions										

Temperature Readings

Time	Day 6		Day 7		Day 8		Day 9		Day 10	
	Black	White	Black	White	Black	White	Black	White	Black	White
9										
12										
3										
Weather Conditions										

1. Paint containers
2. Tie thermometer inside container
3. Fill containers with water
4. Check temperatures

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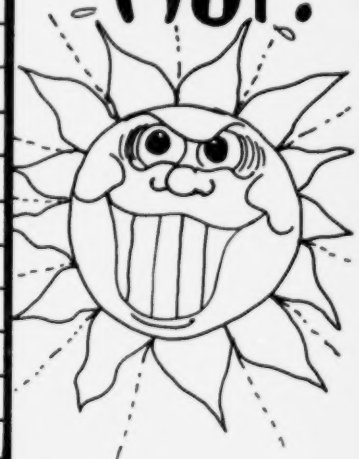
NAME .....

When You're Hot, You're Hot!



Temperature °C

48° 44° 40° 36° 35° 28° 24° 20° 16° 12° 8° 4° 0°

Time

9 12 3 9 12 3 9 12 3 9 12 3 9 12 3 9 12 3 9 12 3 9 12 3 9 12 3 9 12 3

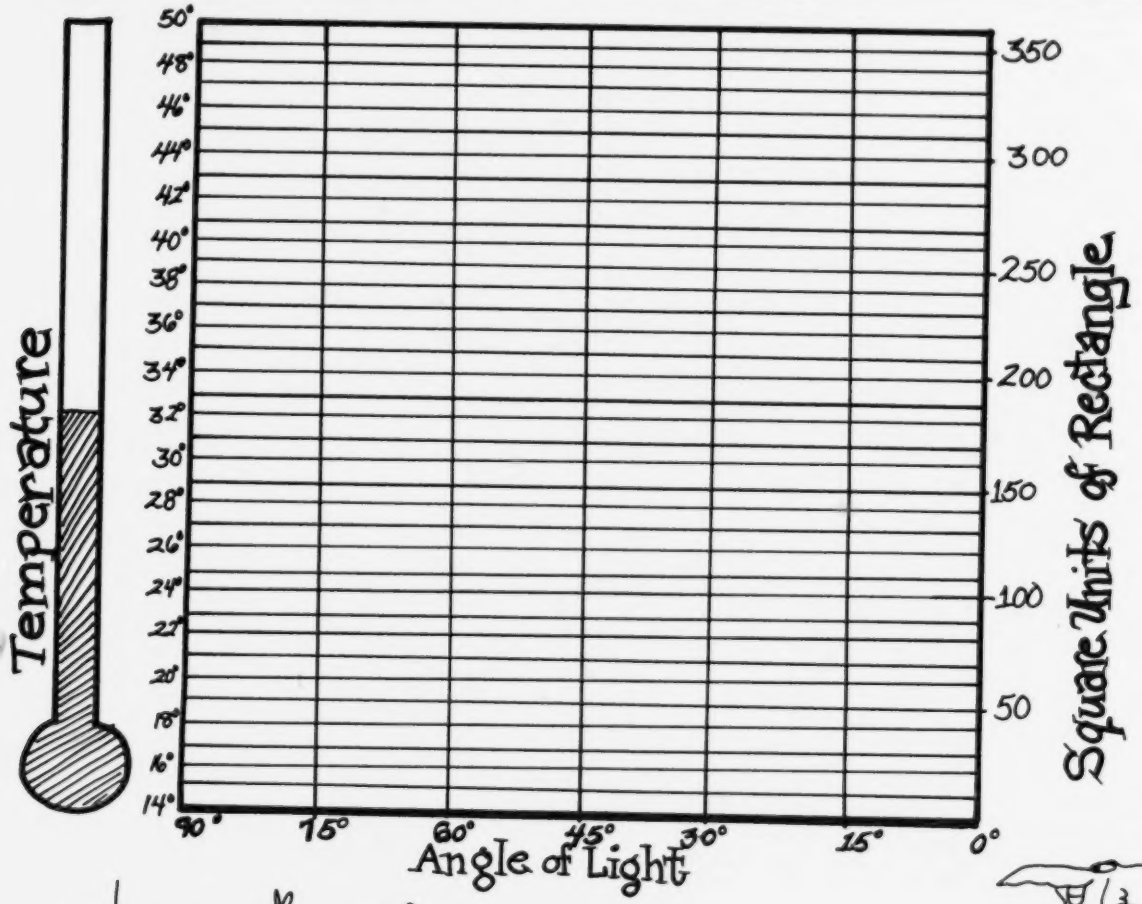
DAY 1 DAY 2 DAY 3 DAY 4 DAY 5 DAY 6 DAY 7 DAY 8 DAY 9 DAY 10

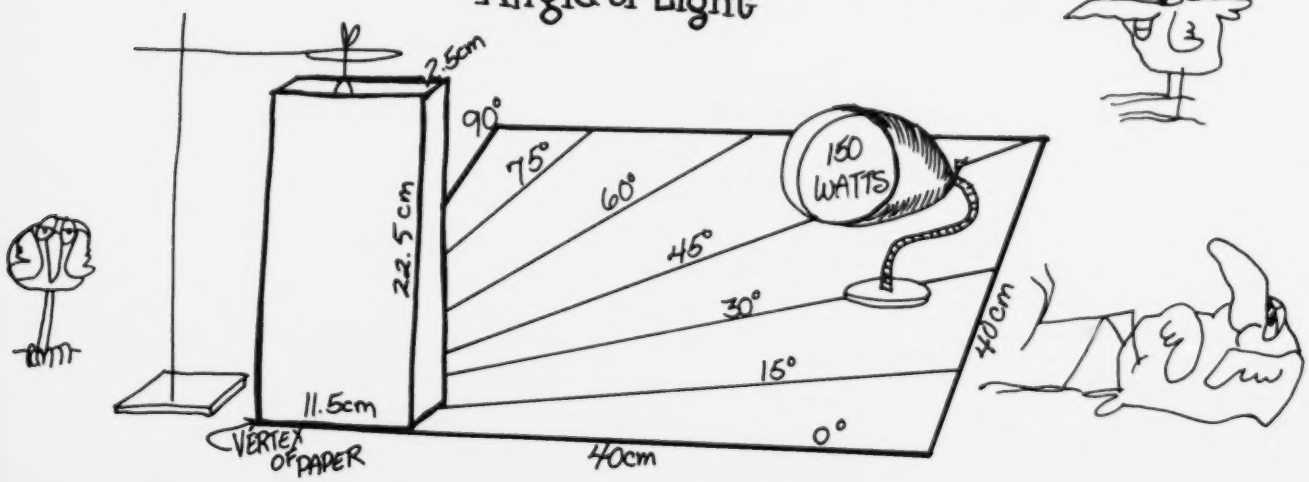
Time

HOT SPOT

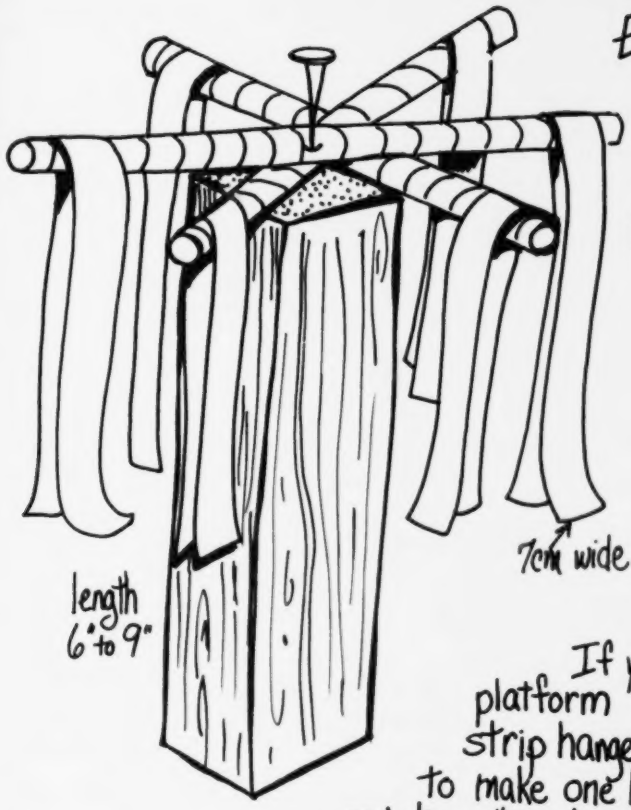
NAME _____

Degree of Angle of Light	90°	75°	60°	45°	30°	15°	0°	LINE COLOR
Temperature after 5 min.								
Square units of graph paper								



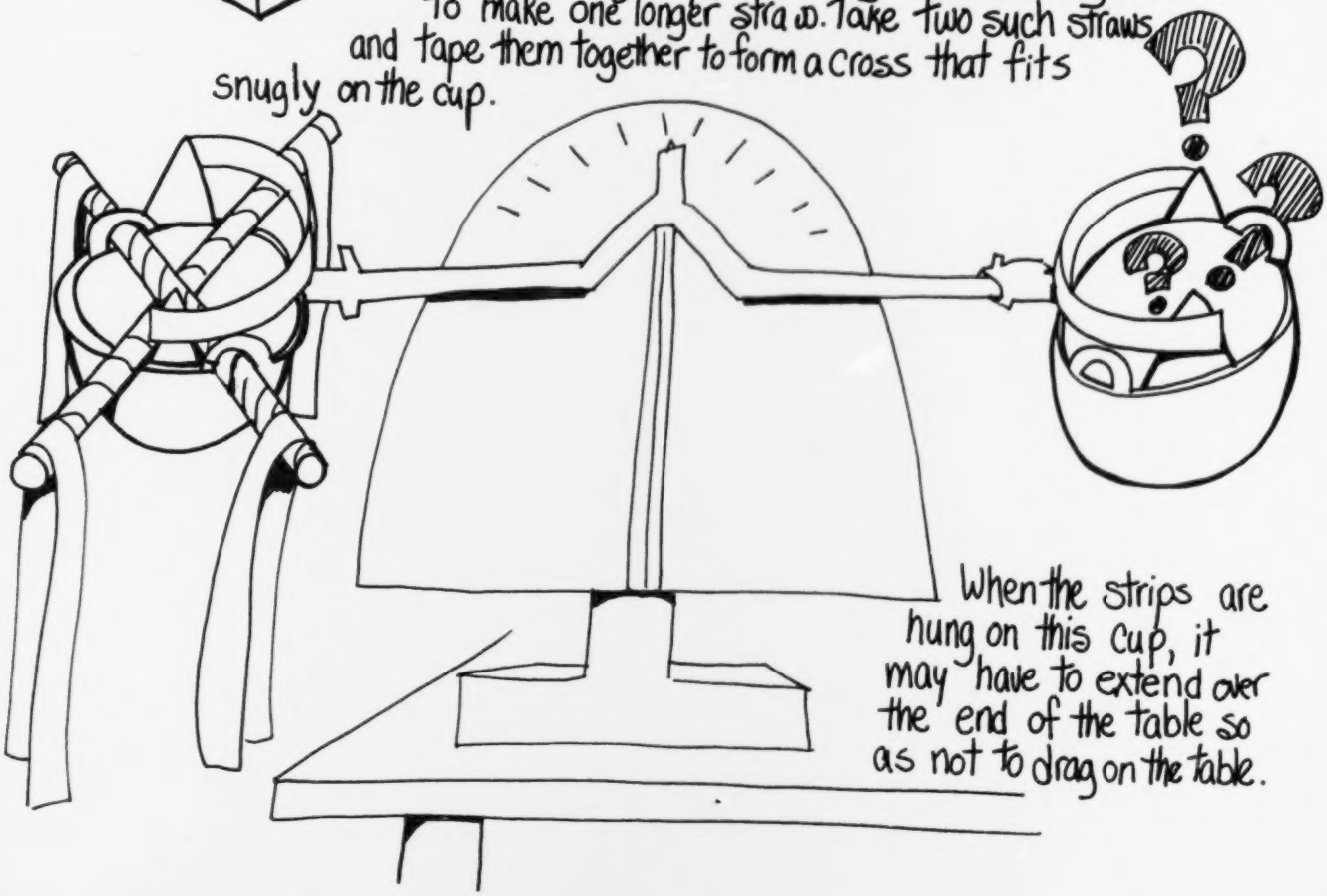


Evaporative Strip Hanger



Stand 2"x2" piece upright. Place 1 straight pin through the center of 3 straws and attatch to the top of 2"x2" as shown.

If you have cup balances rather than platform balances you may make the evaporative strip hanger by connecting two straws together to make one longer straw. Take two such straws and tape them together to form a cross that fits snugly on the cup.



When the strips are hung on this cup, it may have to extend over the end of the table so as not to drag on the table.

Evap-o-Weight

NAME _____

CONDITIONS of TEST	
Temperature:	
Wind:	
Humidity:	
Sunlight:	
Surface Area:	
Liquid:	
Wick:	

Grams Removed	Time Starting:	Time Elapsed	Ratio: g / time elapsed	Rate: g per minute
1				
2				
3				
4				
5				
6				
7				
8				
		Total:		
		Average Rate		

CONDITIONS of TEST	
Temperature:	
Wind:	
Humidity:	
Sunlight:	
Surface Area:	
Liquid:	
Wick:	

Grams Removed	Time Starting:	Time Elapsed	Ratio: g / time elapsed	Rate: g per minute
1				
2				
3				
4				
5				
6				
7				
8				
		Total:		
		Average Rate		

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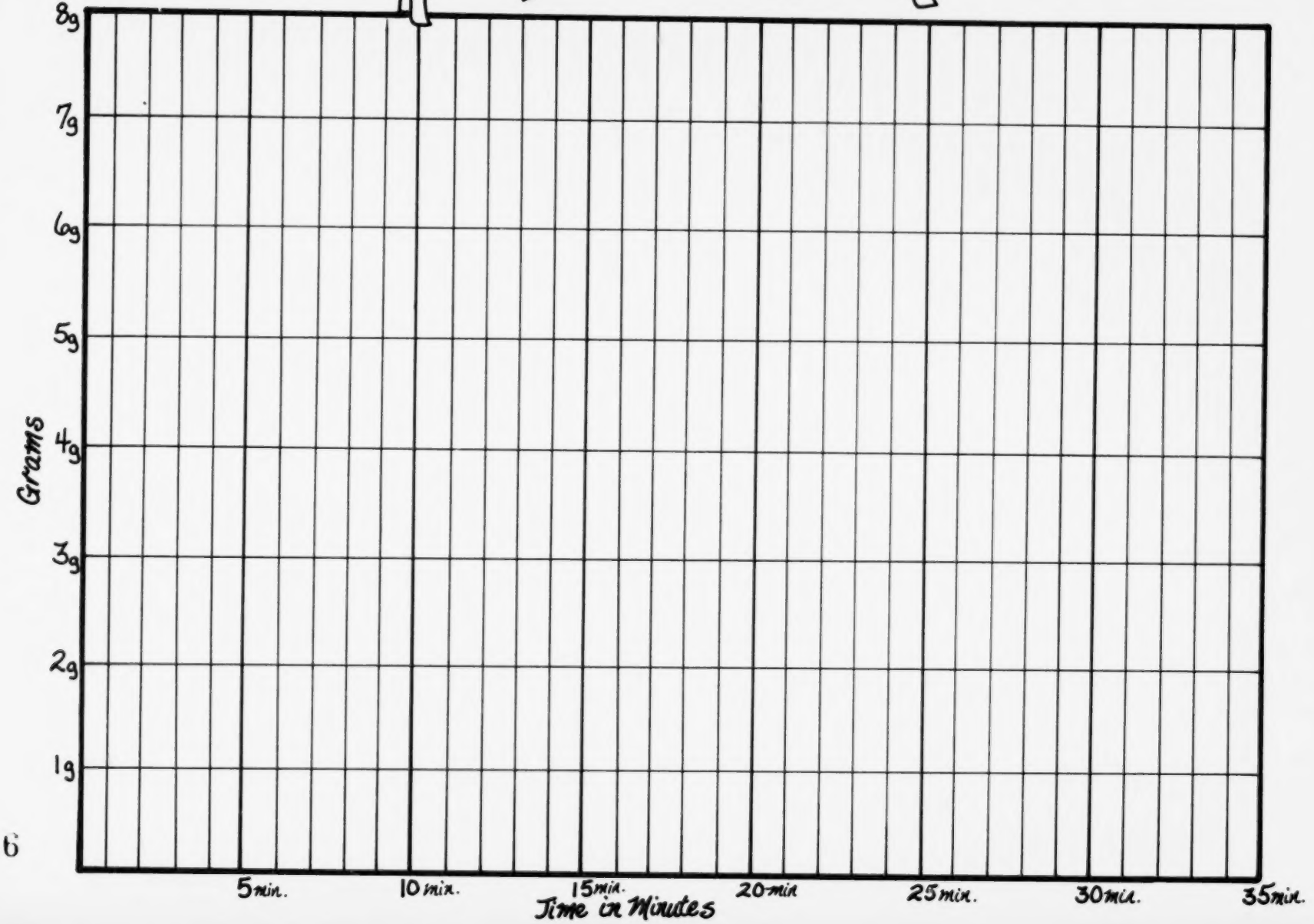
Evap-o-Weight

NAME _____



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TEMP-RATE

METEOROLOGIST _____

DAY 1

Date: _____

Weather Condition: _____

Record Temperature at:

a. 9:00 am. _____ °C

b. 12:00 noon _____ °C

c. 2:00 pm. _____ °C

_____ °C total

Daily temperature average _____ °C ÷3

DAY 2

Date: _____

Weather Condition: _____

Record Temperature at:

d. 9:00 a.m. _____ °C

e. 12:00 noon _____ °C

f. 2:00 p.m. _____ °C

_____ °C total

Daily temperature average _____ °C ÷3

DAY 3

Date: _____

Weather Condition: _____

Record temperature at: _____

g. 9:00 a.m. _____ °C

h. 12:00 noon _____ °C

i. 2:00 p.m. _____ °C

_____ °C total

Daily Average Temperature _____ °C ÷3

DAY 4

Date: _____

Weather Condition: _____

Record Temperature at: _____

j. 9:00 a.m. _____ °C

K. 12:00 noon _____ °C

l. 2:00 p.m. _____ °C

_____ °C total

Daily temperature average _____ °C ÷3

DAY 5

Date: _____

Weather Condition: _____

Record Temperature at: _____

m. 9:00 a.m. _____ °C

n. 12:00 noon _____ °C

o. 2:00 p.m. _____ °C

_____ °C total

Daily temperature average _____ °C ÷3

AVERAGES

DAY 1 average _____ °C

DAY 2 average _____ °C

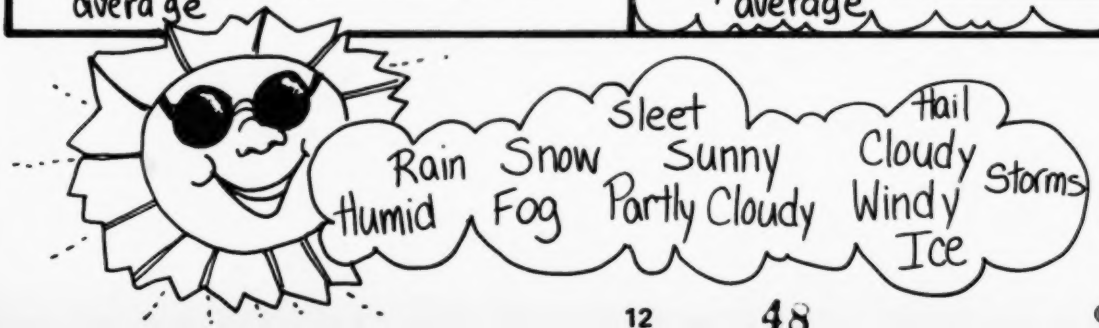
DAY 3 average _____ °C

DAY 4 average _____ °C

DAY 5 average _____ °C

_____ °C Total

Weekly temperature average _____ °C ÷5



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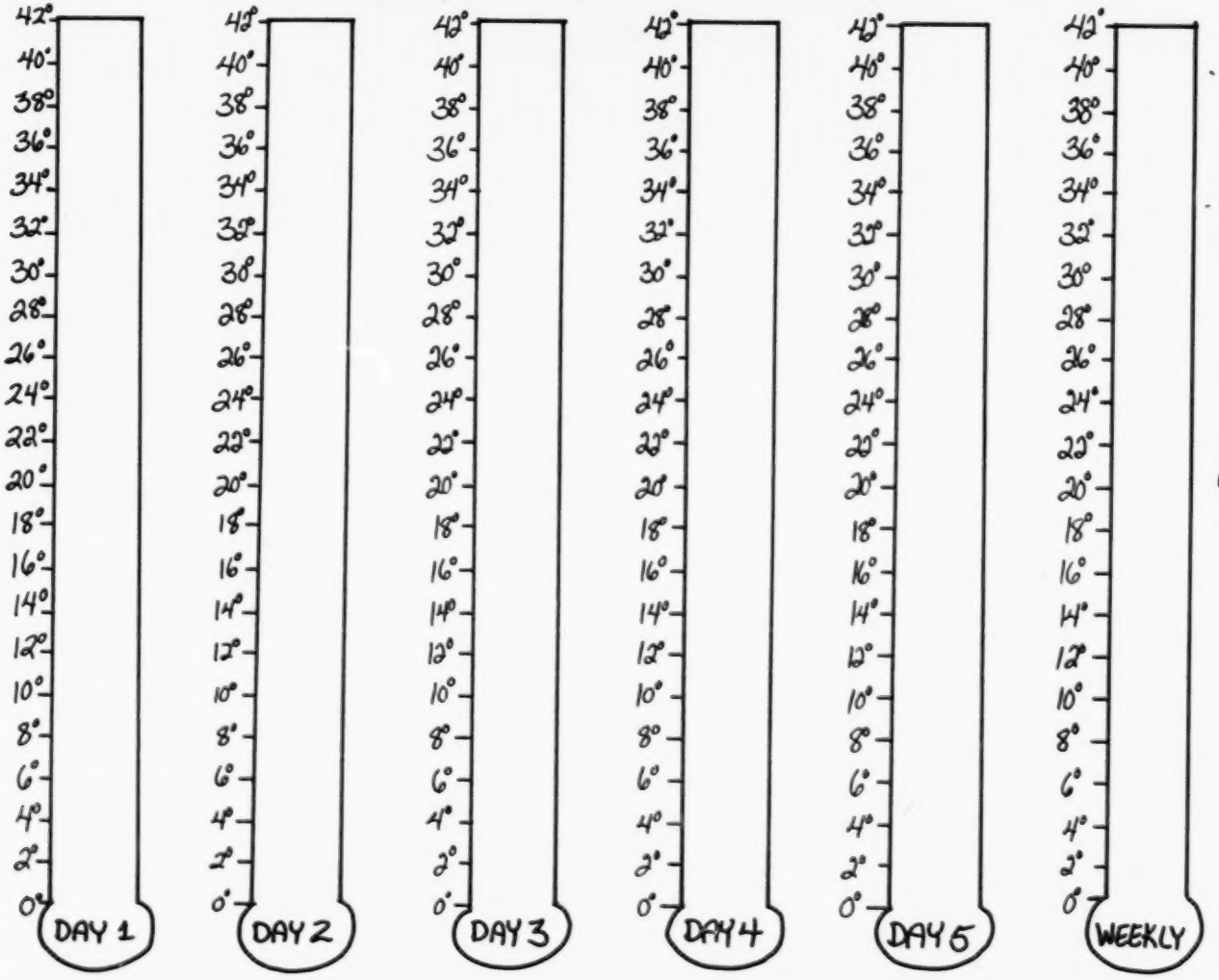
TEMP-RATE

Meteorologist

Make a thermometer graph of your average daily temperatures and the weekly temperature average.

Degrees in Celsius



How does weather condition affect temperature?

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Every Breath You Take

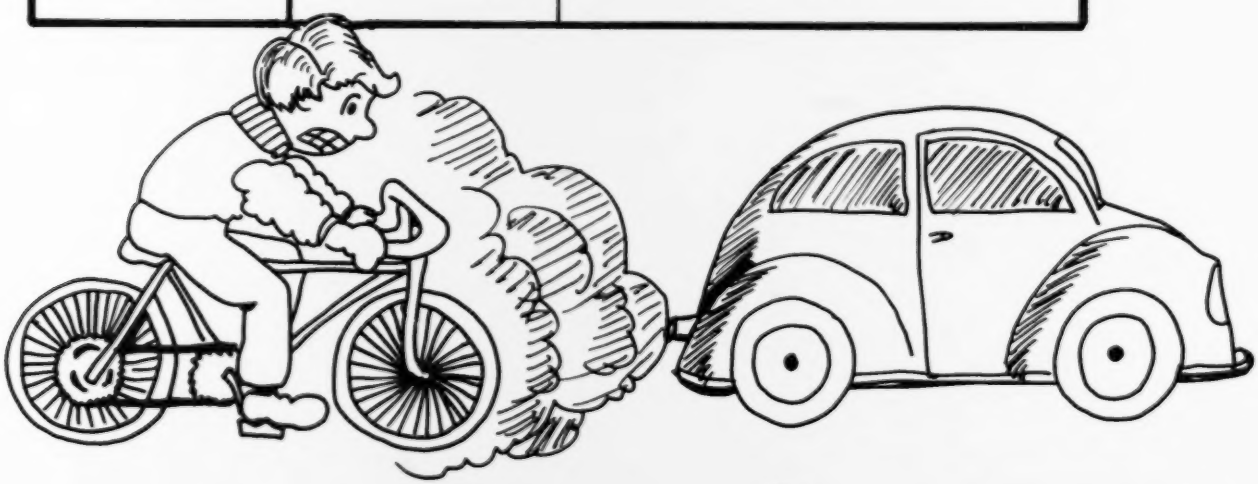
NAME _____

How much air pollution does a car produce in one minute?

WEIGHT OF BAG	WEIGHT OF BAG + POLLUTION	WEIGHT OF POLLUTION	TIME REQUIRED TO FILL BAG	POLLUTION PER MINUTE
g	g	g		

Pounds = Grams X .0022

	NUMBER OF CARS	POLLUTION IN GRAMS	POLLUTION IN POUNDS
Per Minute	_____	_____ X .0022 =	_____
Per Hour	_____	_____ X .0022 =	_____
Per Day	_____	_____ X .0022 =	_____
Per Year	_____	_____ X .0022 =	_____



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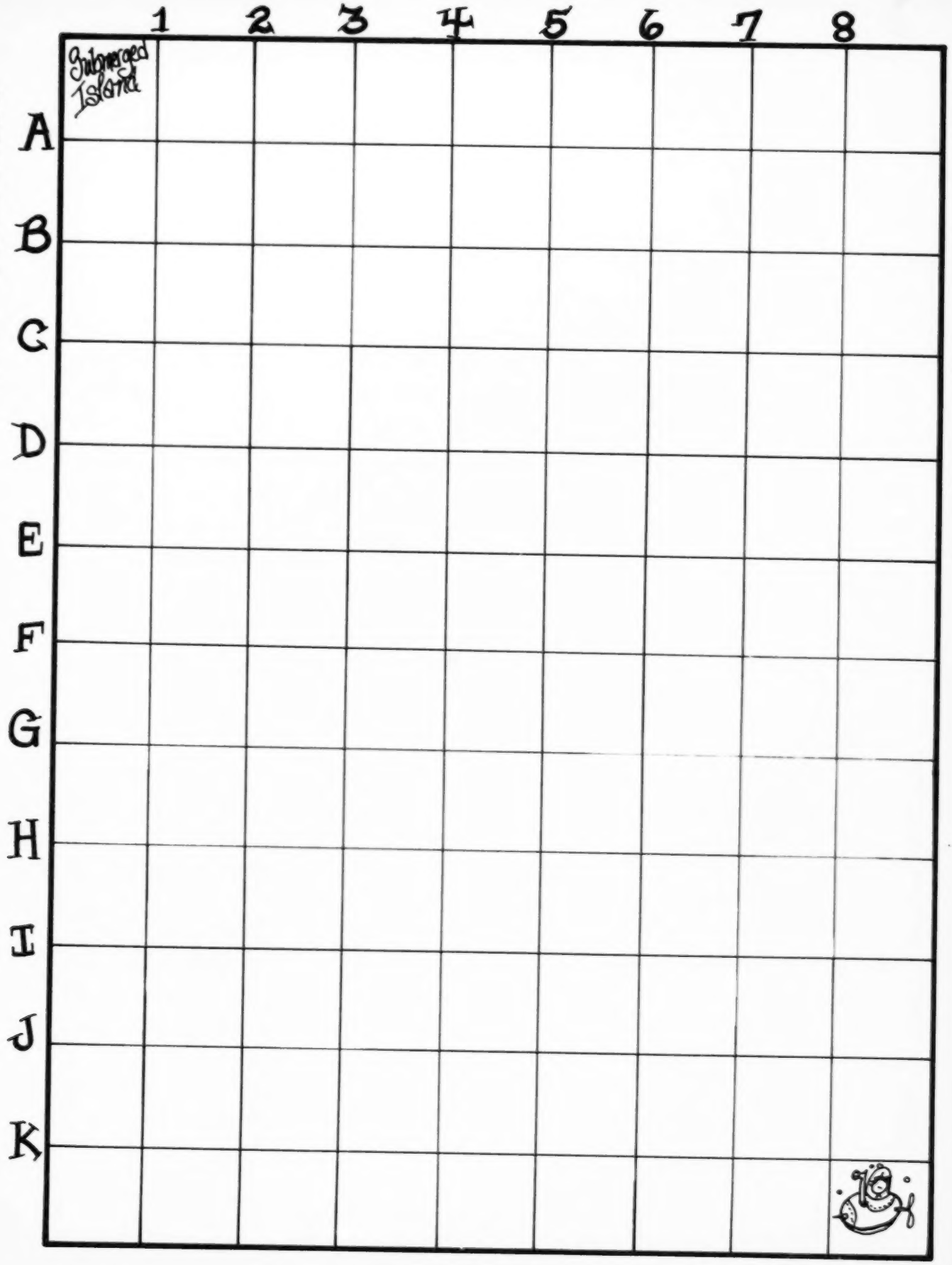
Name ----------



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Mapping The Ocean Floor

Drop each object 5 times. Record the time it takes to reach the bottom. Find the Average.

Name _____

	Penny	Plastic Bag Fastener	Rubber Band	Paper Clip	Thumbtack
Drop 1					
Drop 2					
Drop 3					
Drop 4					
Drop 5					
Total					
Average					

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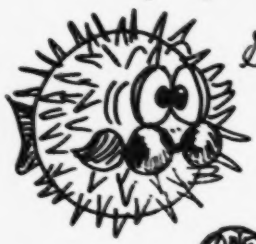
Mapping The Ocean Floor



Graph the Average Time in Seconds for each item dropped. Color your graph to represent the ocean water and ocean floor.

Name _____

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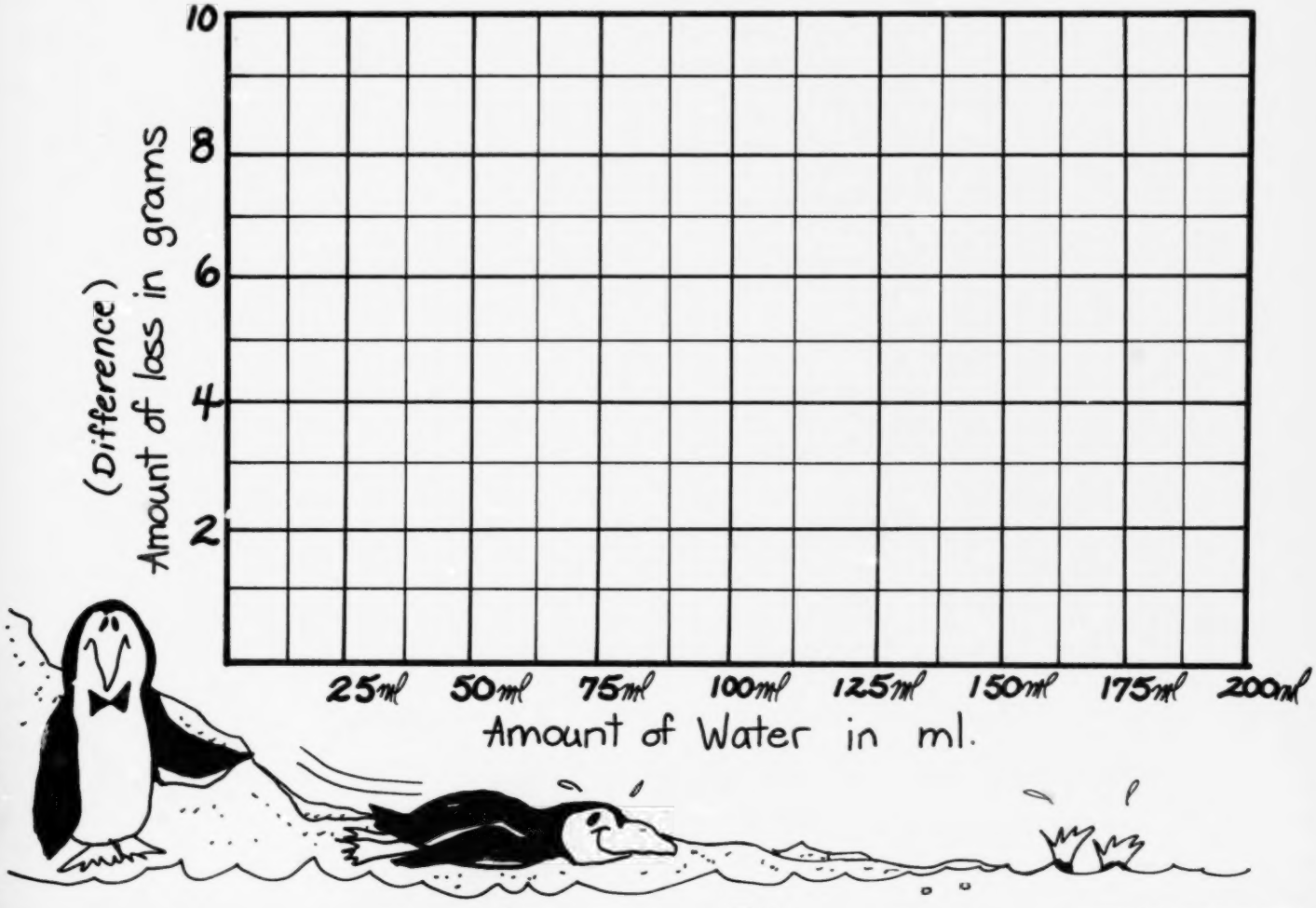
Name _____

	A	B	C	D	E	F	G	H
Weight of container (g)								
Amount of Water	25ml	50ml	75ml	100ml	125ml	150ml	175ml	200ml
Total (g)								
Weight when Frozen (g)								
Difference (g)								



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NAME _____

ICEBERGS	A	B	C	D	E	F	G	H
MASS IN GRAMS								
WATER DEPTH without Iceberg								
WATER DEPTH with Iceberg								
Difference								
Density								

Density is the measure of mass per unit volume. $D = \frac{\text{mass}}{\text{volume}}$

Density = mass(g) ÷ volume (cc)

1ml = 1cc

ICEBERGS	MASS(g)	VOLUME (cc)	=	DENSITY (grams per cubic cm)
A	_____	÷ 25 cc	=	_____ g/cc
B	_____	÷ 50 cc	=	_____ g/cc
C	_____	÷ 75 cc	=	_____ g/cc
D	_____	÷ 100 cc	=	_____ g/cc
E	_____	÷ 125 cc	=	_____ g/cc
F	_____	÷ 150 cc	=	_____ g/cc
G	_____	÷ 175 cc	=	_____ g/cc
H	_____	÷ 200 cc	=	_____ g/cc

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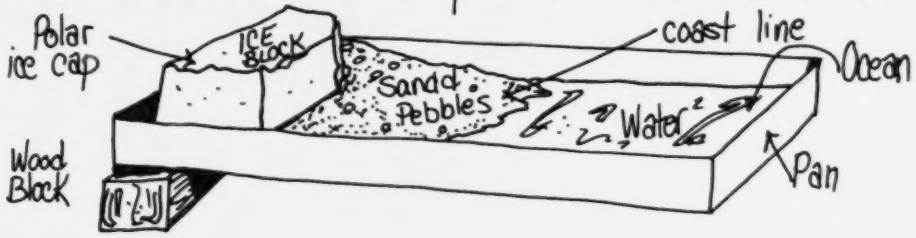
Name _____

When Polar Ice Caps Melt

1. In a pan with half sand and half water, set up a block of ice on the sand half. Elevate one end of the pan so the sand does not absorb water.



2. Measure the depth of water in the pan at the deepest point.

Depth at deepest point.... _____ mm

3. Compute the volume of the block of ice. (Volume = length x width x height)

length = _____ mm

width = X _____ mm

_____ mm^2 x height _____ mm = _____ mm^3

4. Compute the area of the water surface. (Area = length x width)

length = _____ mm

width = X _____ mm

_____ mm^2 Area of water surface

5. To predict the rise in water level after the ice melts, divide Volume of ice block by the area of water surface.

$$\frac{\text{Volume of ice block}}{\text{Area of water surface}} = \frac{\text{mm}^3}{\text{mm}^2} = \text{_____ mm Rise in water level}$$

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Name _____

When Polar Ice Caps Melt (pg. 2)

6. Every hour during the melt down time of the ice cap, observe what is happening to the model and answer the following questions:

   A. What is happening to the ice block? _____

   _____

   B. What is happening to the sand under the ice block? _____

   _____

   C. What is the difference between the sand under the ice block and the sand not under the ice block? _____

   _____

7. When the polar ice cap (ice block) has completely melted measure the depth of the water in the pan at the deepest point again. Subtract your original measurement (depth before polar ice cap melted) from the final (after polar ice cap melted) measurement.

   After polar ice cap melt= _____ mm
   Before polar ice cap melt= – _____ mm
   _____ = measured rise in water level

8. How close did you come to your mathematical prediction in the rise in water level?

   Mathematical prediction of rise in water level _____ mm
   Measured rise in water level _____ mm
   Difference between the two _____ mm

9. Investigate the area that was under the block of ice and compare that area with the sand that was not under the block of ice.

   _____

   _____

   _____

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HEAT SALTY CHANGE

NAME _____

FIRST.... What happens to boiling water when salt is added?

1. Put 40 ml of water in a beaker. Suspend a thermometer in the water so that it does not touch the bottom of the beaker.

2. Measure the starting temperature of the water and record it in the space marked 0.

3. Begin heating the water; as the water heats measure and record its temperature every minute. Do this for at least 3 minutes after the water boils.

	TIME OF HEATING IN MINUTES							
WATER	0	1	2	3	4	5	6	7
TEMPERATURE IN C°								

4. Make a line graph to show your results and label "water."

NEXT....

5. Put 40 ml of water in a beaker. Add 2 teaspoons salt. Stir. Now repeat the experiment.

	TIME OF HEATING IN MINUTES							
SALT WATER	0	1	2	3	4	5	6	7
TEMPERATURE IN C°								

6. Make a line graph to show your results and label "salt solution."

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COLD SALTY CHANGE

NAME _____

What happens to freezing water when we add salt? _____

FIRST....

1. Place 40 ml of water into a styrofoam cup or beaker. Measure the temperature and record under 0.

2. Add 2 or 3 crushed ice cubes to the water. As the water cools, take its temperature every minute and record.

	Time of Cooling in Minutes							
WATER	0	1	2	3	4	5	6	7
TEMPERATURE IN C°								

3. Make a line graph to show your results and label it "water."

NEXT....

4. Place 40 ml of water into a styrofoam cup or beaker. Add 2 teaspoons of salt. Stir. Measure the temperature and record under 0. Crush 2 or 3 ice cubes and add to the water.

5. As the SALT water cools, take its temperature every minute and record.

	TIME OF COOLING IN MINUTES							
SALT WATER	0	1	2	3	4	5	6	7
TEMPERATURE IN C°								

6. Make a line graph to show your results and label "salt solution."

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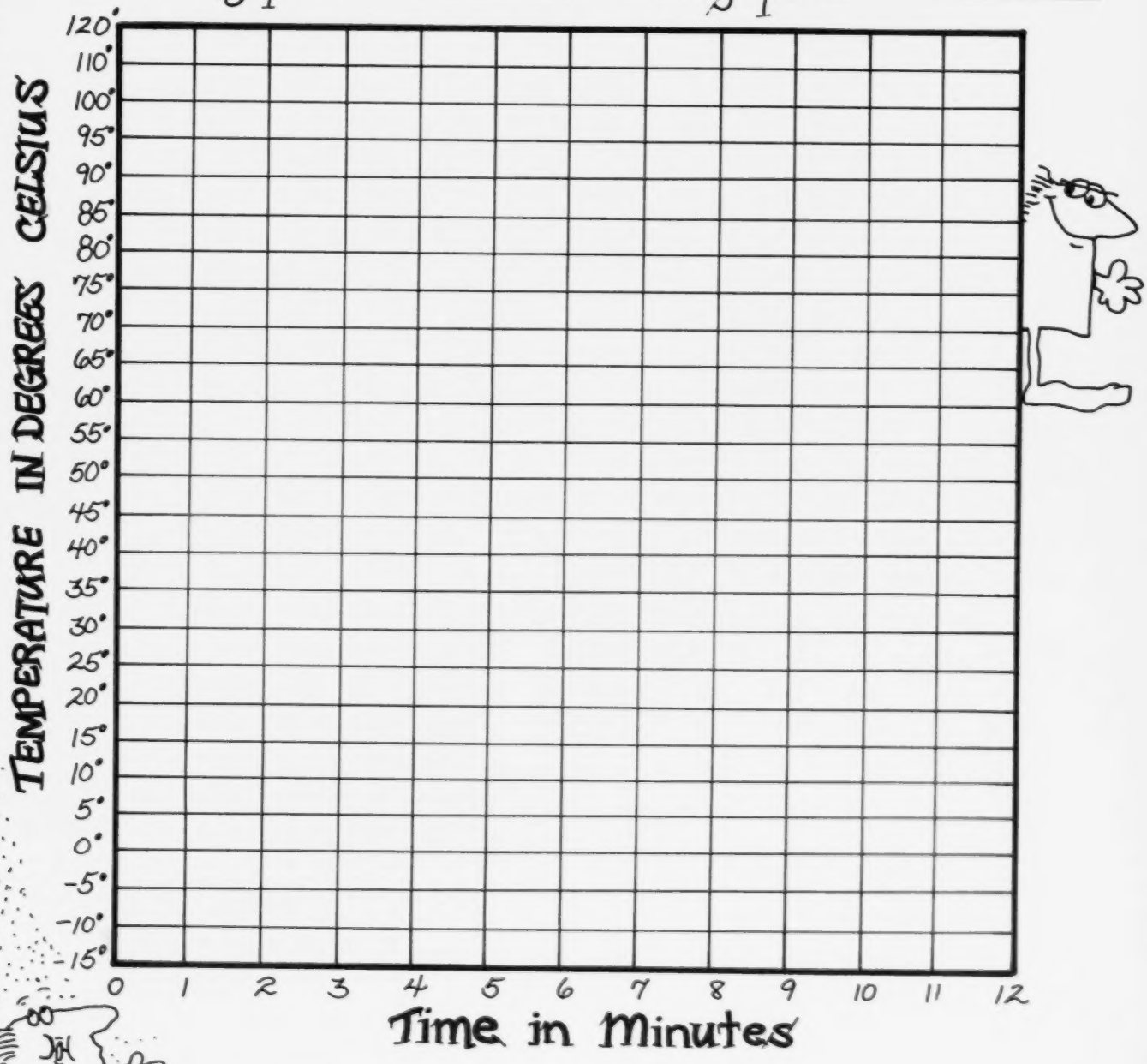
NAME _____

SALTY CHANGE

WATER SOLUTION		SALT SOLUTION	
lowest temperature	_____	lowest temperature	_____
highest temperature	_____	highest temperature	_____
boiling point	_____	boiling point	_____



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WHAT ON EARTH WE DO?

NAME _____

ESTIMATED WEIGHT	
WEIGHT OF CAN AND SOIL (W_1)	
WEIGHT OF CAN (W_2)	
WEIGHT OF SOIL ($W_1 - W_2$)	

Slowly and carefully, take your soil sample apart, sorting it as you go into categories. Describe what you find.

SOIL FEELS:	
SOIL SMELLS:	
SOIL IS MADE OF:	
LIVING THINGS FOUND:	
TYPE OF SOIL: (Give it a name)	

Put your soil sample back together exactly the way you got it. Can you do it?

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It's All WET!

Name _____

1. Fill each tin can with soil within 2cm to top.
2. Next, fill can full of water.
3. Every 10 minutes remove the coffee can and measure the amount of water collected in a graduated cylinder.
4. Discard measured water.

Type of Soil	Mass of Soil	Volume of Water Added	Volume of Water Lost in:					
			10 min.	20 min.	30 min.	40 min.	50 min.	60 min.

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Sands of Time

NAME _____

ESTIMATE PERCENTAGES OF SAND PARTICLES:

Quartz		Biotite Mica		Pyrite	
Iron		Muscovite Mica		Feldspar	
Misc.					

MINERALS / %	SAMPLE #1	SAMPLE #2	SAMPLE #3	SAMPLE #4	SAMPLE #5	SAMPLE #6	TOTAL	% # of SAMPLES	GROUP AVERAGE %
QUARTZ									
IRON									
BIOTITE MICA									
MUSCOVITE MICA									
PYRITE									
FELDSPAR									
MISC.									
TOTAL									

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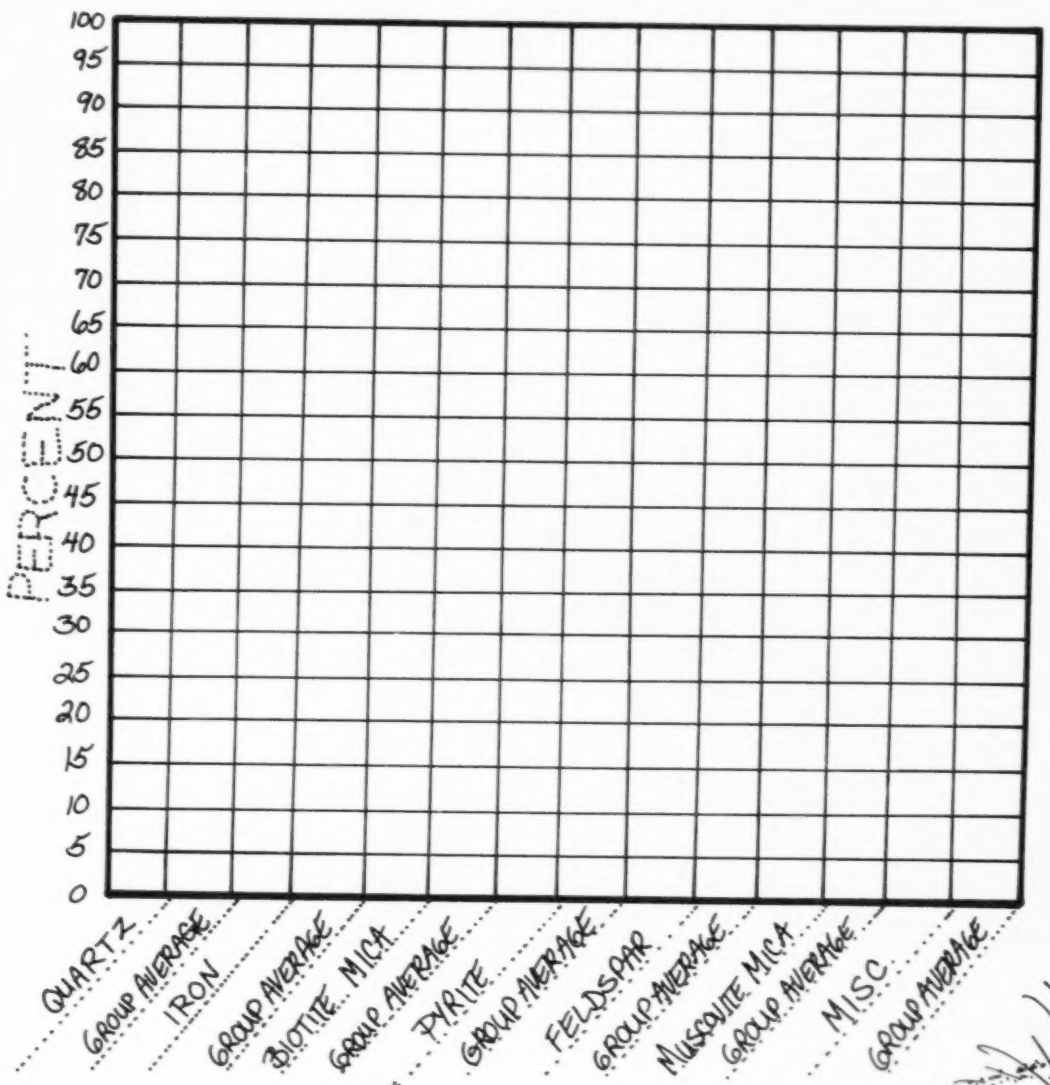
Sands of Time

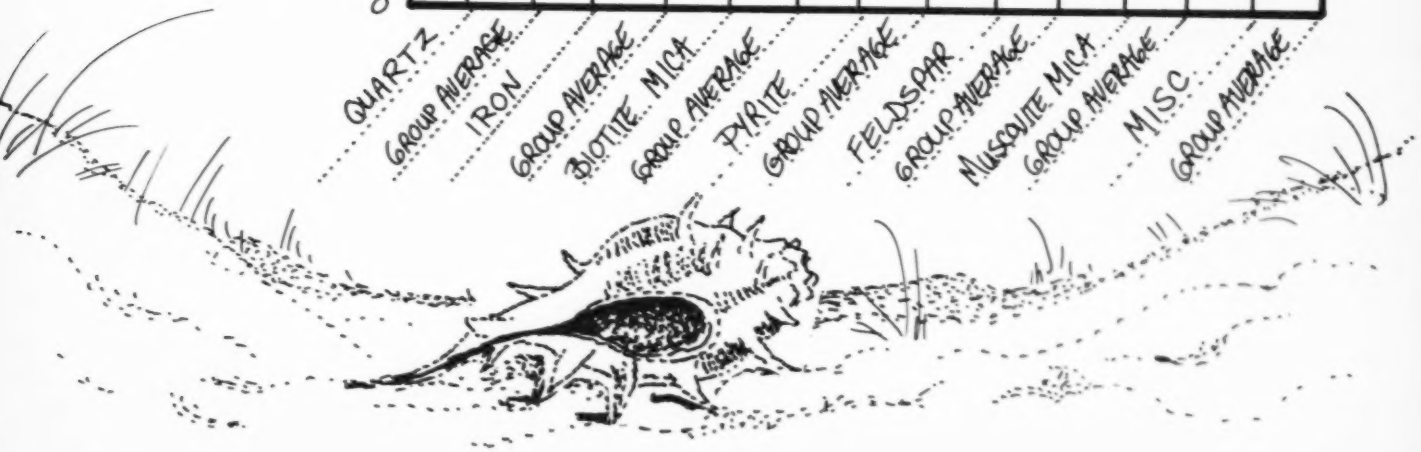
NAME

Color code your minerals and graph your results.

MINERAL COLOR CODE:

- QUARTZ
- IRON
- BIOTITE MICA
- PYRITE
- FELDSPAR
- MUSCOVITE MICA
- MISC.





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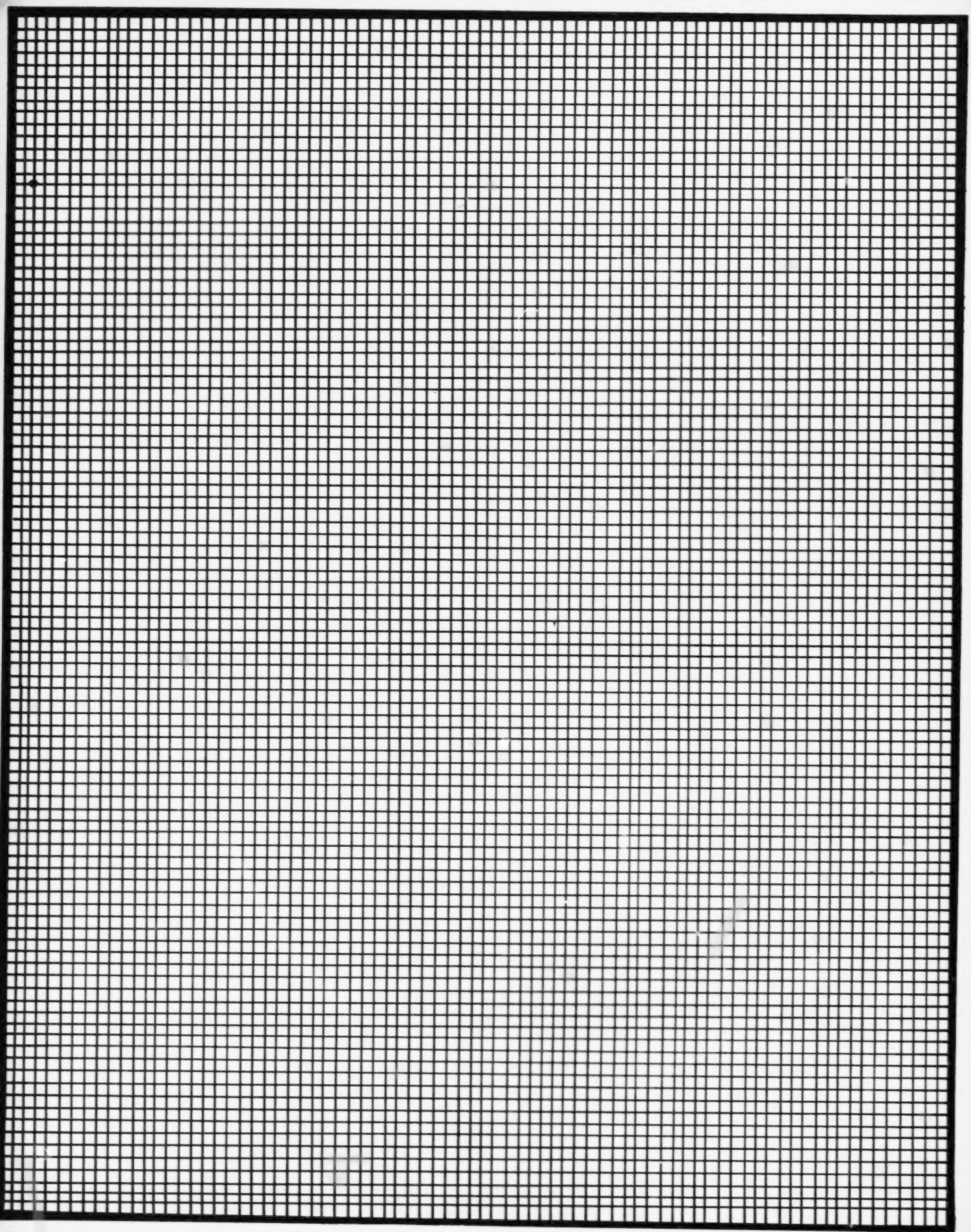

NAME _____

SHOOT THE RAPIDS

Slope	5°	10°	15°	20°	25°
Trial #1 (sec.)					
Trial #2 (sec.)					
Trial #3 (sec.)					
Trial #4 (sec.)					
Trial #5 (sec.)					
Total Time (sec.)					
Average Time (sec)					

Slope	Length of Run ÷ Average time = Velocity cm/sec.
5°	_____ cm ÷ _____ sec. = _____ cm/sec.
10°	_____ cm ÷ _____ sec. = _____ cm/sec.
15°	_____ cm ÷ _____ sec. = _____ cm/sec.
20°	_____ cm ÷ _____ sec. = _____ cm/sec.
25°	_____ cm ÷ _____ sec. = _____ cm/sec.

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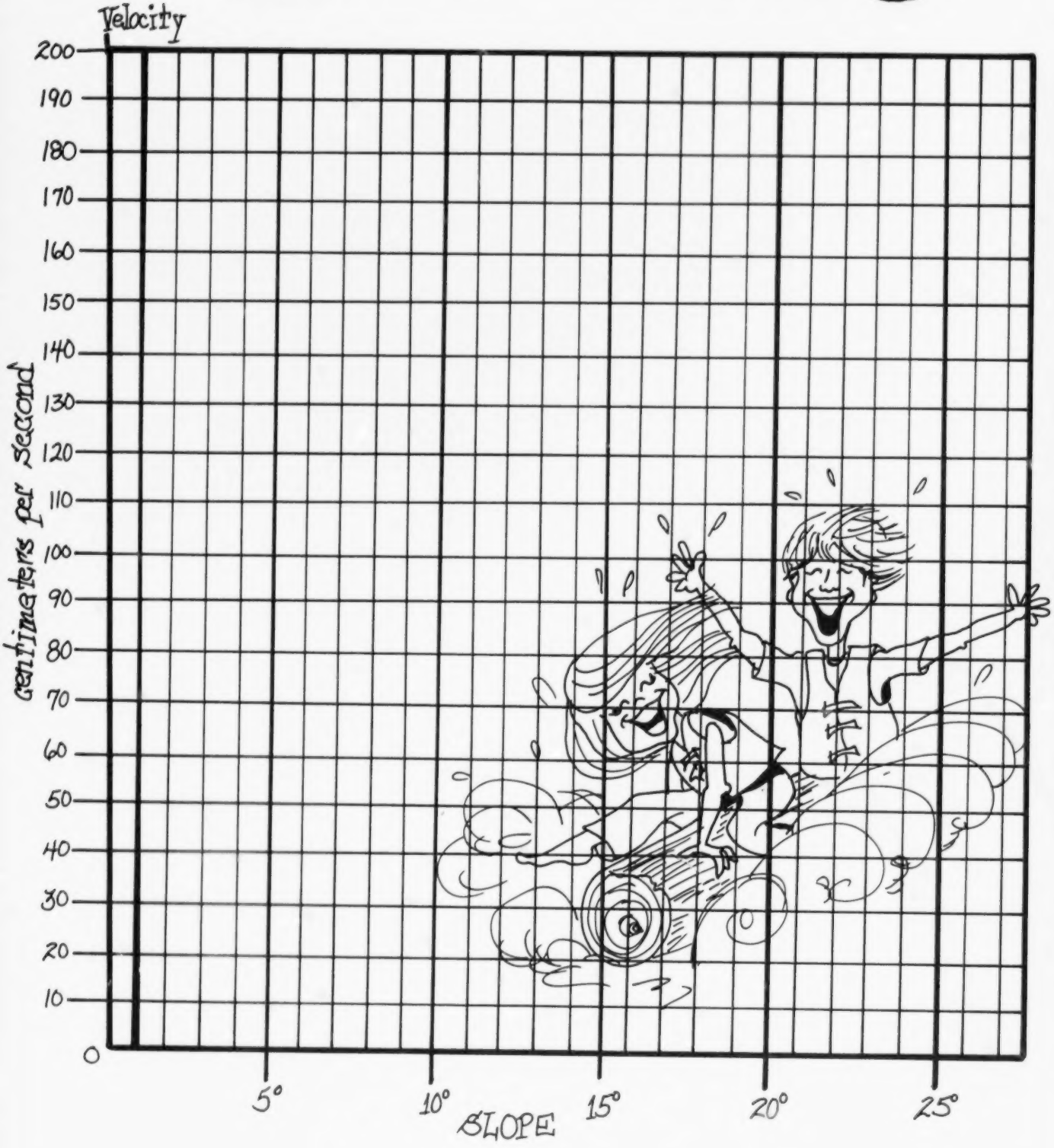
NAME _____

SHOOT THE RAPIDS



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FLOOD STAGE

NAME _____

Do you float faster on a river when it's at flood stage?

1. Set the volume measure at the low end of the trough. Time how long it takes to collect 200ml with 1, 2, 3 & 4 tubes open. Record.

	1 TUBE	2 TUBES	3 TUBES	4 TUBES
seconds to fill 200 ml				
Trial # 1				
Trial # 2				
Trial # 3				
Trial # 4				
Trial # 5				
Total Time for Trials				
Average Time in seconds				

2. Open 1 siphon tube. Time the number of seconds it takes for a toothpick to float the length of the run. Repeat for a total of 5 trials. Record and find the average time. Do the same for 2, 3, and 4 tubes open.

3. Use your findings to compute the Rate of Flow and Velocity of your "River".

(RATE OF FLOW) = ml ÷ seconds to fill = ml/sec.

		RATE OF FLOW	
1 Tube = 200 ml ÷ _____	sec. to fill	= _____	ml/sec.
2 Tubes = 200 ml ÷ _____	sec. to fill	= _____	ml/sec.
3 Tubes = 200 ml ÷ _____	sec. to fill	= _____	ml/sec.
4 Tubes = 200 ml ÷ _____	sec. to fill	= _____	ml/sec.

(VELOCITY) = cm ÷ Average seconds = cm/sec.

Length of Run — Average Time

		VELOCITY	
1 Tube = _____ cm ÷ _____	sec.	= _____	cm/sec.
2 Tubes = _____ cm ÷ _____	sec.	= _____	cm/sec.
3 Tubes = _____ cm ÷ _____	sec.	= _____	cm/sec.
4 Tubes = _____ cm ÷ _____	sec.	= _____	cm/sec.

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FLOOD STAGE

NAME _____

VELOCITY cm/sec.

RATE OF FLOW ml/sec.

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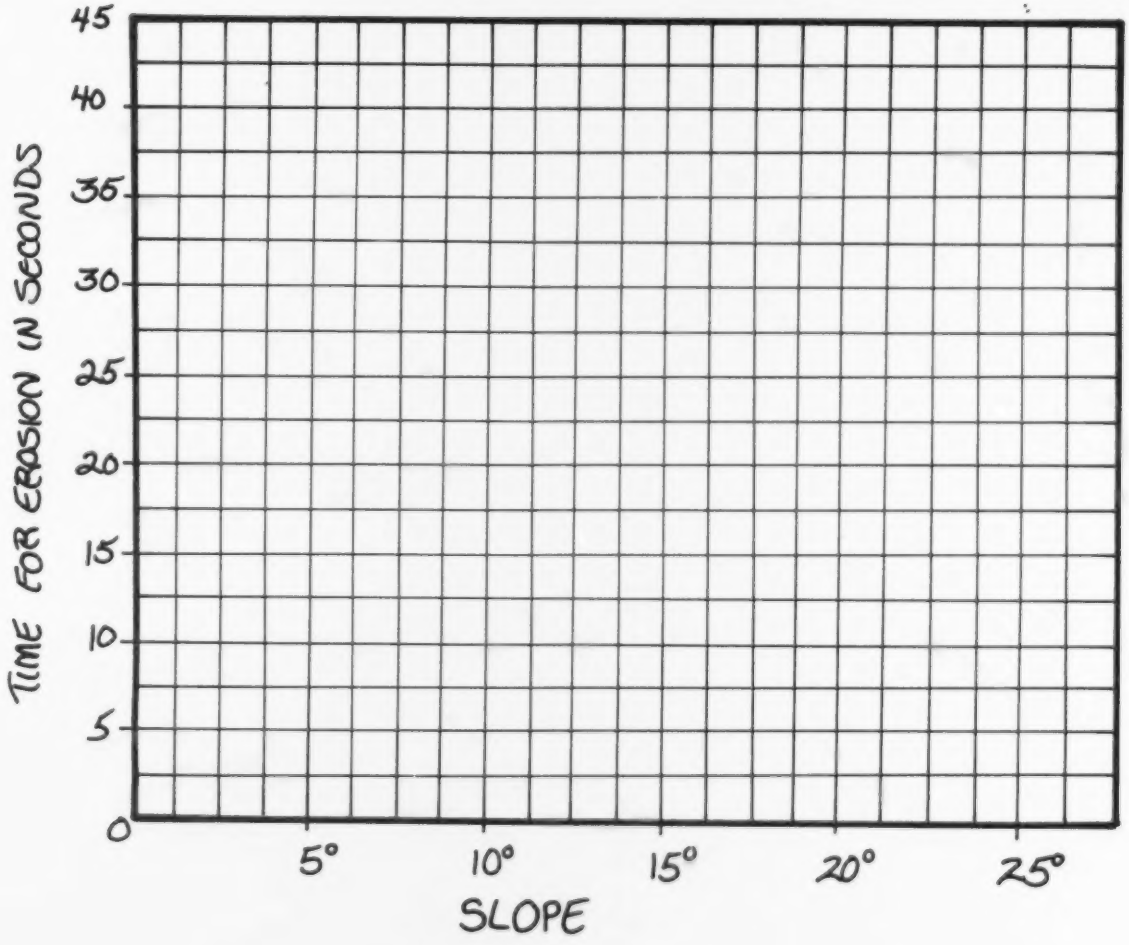
NAME

PART I

Quick Sand

	SLOPE 5°	10°	15°	20°	25°
TRIAL 1	sec	sec	sec	sec	sec
TRIAL 2	sec	sec	sec	sec	sec
TRIAL 3	sec	sec	sec	sec	sec
TOTAL	sec	sec	sec	sec	sec
AVERAGE	sec	sec	sec	sec	sec



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Quick Sand

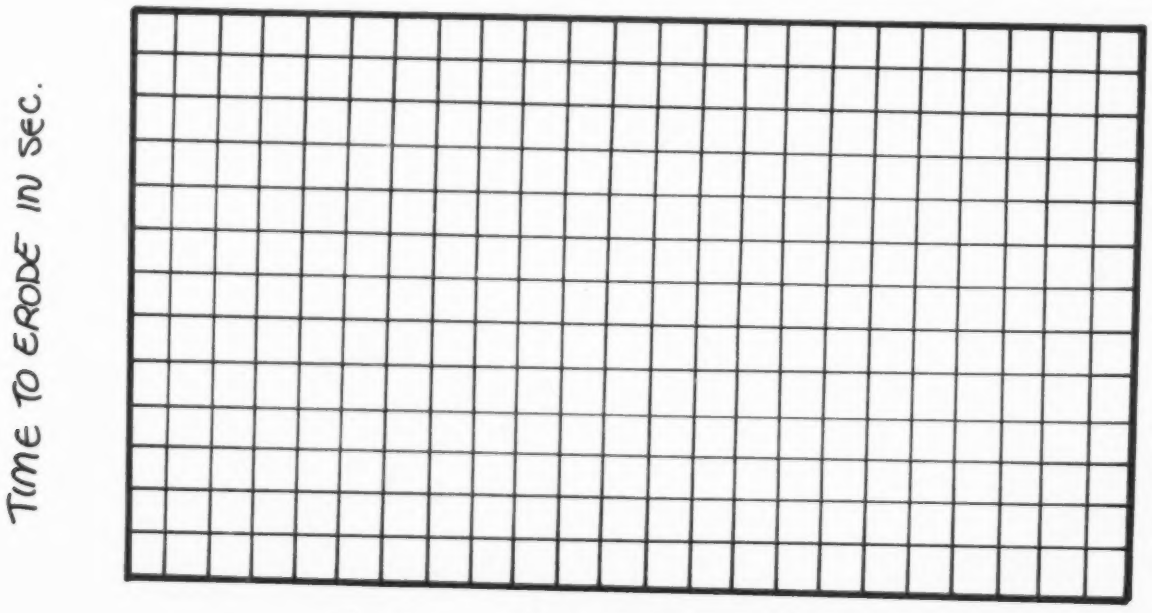
PART II

NAME _____

	1 TUBE	2 TUBES	3 TUBES	4 TUBES
TRIAL 1	sec	sec	sec.	sec.
TRIAL 2	sec	sec	sec.	sec.
TRIAL 3	sec	sec.	sec.	sec.
TOTAL	sec	sec.	sec.	sec.
AVERAGE	sec	sec.	sec.	sec.
TIME TO FILL 200ml	sec	sec.	sec.	sec.

RATE OF FLOW

VOLUME ÷ TIME			RATE
1 TUBE = 200ml ÷	_____ sec. to fill	=	_____ ml/sec.
2 TUBES = 200ml ÷	_____ sec. to fill	=	_____ ml/sec.
3 TUBES = 200 ml ÷	_____ sec. to fill	=	_____ ml/sec.
4 TUBES = 200ml ÷	_____ sec. to fill	=	_____ ml/sec.



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pg. 1

PROSPECTOR'S INSTRUCTIONS

MAKING A MOUNTAIN

1. Measure out a portion of salt, sawdust, iron filings, and sand to total 15 grams, with at least 2 grams of each one. Record the mass of each: salt_____ sawdust_____ iron filings_____ sand_____
2. Get plaster and a cup from the teacher.
3. Mix your 4 materials into one mixture. Layer your mountain by putting in a spoonful of plaster and a spoonful of your material until the material is gone and your cup is full. Stir the combination no more than 10 times.
4. Label the cup and let the plaster dry. Give your teacher a record of the masses of the substances in your mountain.

MINING A MOUNTAIN

1. Determine the sequence of your Group's Mining Procedure. Record this on "*Prospector's Report*" under "*Mining Procedure*", p.32.
2. Determine what equipment is needed. Record this on "*Prospector's Report*" under "*Equipment Requisitioned.*"
3. Mine and extract materials following your procedure. Record all the time miners are working on the project under "*Miner's Time Card.*"
4. When all the materials have been extracted to your satisfaction, measure the mass of material and record under "*Total Mine Output.*"

EVALUATING A MINE

1. Now change roles from a miner to a company evaluator. You will determine if your mine is profitable and should continue operation. Use the "*Evaluator's Annual Report to the Board*" for this. Costs and prices for this form are found in the "*Miner's Handbook.*"
2. Start with the "*Cost Analysis*" section. Determine the income first. Multiply the quantity of material mined by its price on the Central Commodity Exchange. Find the sum for the sales of all 4 materials. This is your income.

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pg. 2 # PROSPECTOR'S INSTRUCTIONS

3. Determine your expenses. Find the sum of equipment requisitioned. and the cost of paying your employees (personnel).
4. Find the difference in your income and your expenses to see if you have a profit or a loss.
5. Next, determine if you have an effective mining procedure. Ask your teacher how much of each material was in your mountain. Record this in your "*Effectiveness Study* "section" under "*Actual Material*". Use the amount you were able to mine to find the percentage of actual material you recovered.
6. Finally — Make your recommendations to the board. Check one of the recommended actions and explain to the board why you chose it, using your "*Cost Analysis* " and "*Effectiveness Study* " to support your position. Consider the following questions. Answering them should help you write your response.

A. Did the mine make or lose money? _____

_____

B. If it made money, could you make more by using a better mining technique? What would you suggest? _____

_____

_____

C. If it lost money, was it because your mining was ineffective? Could you make more money if you were effective in mining? How could you become more effective? _____

_____

_____

D. Is there too little material to ever make a profit?

_____

E. Could costs be cut by using less personnel or equipment? How? _____

_____

ALLIED MINES

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ALLIED MINES

•>> MINER'S HANDBOOK <<•

ACE MINING EQUIPMENT
• PRICE LIST •

ORE CRUSHER HAMMER TYPE – $35.99
SETTLING TANK – $17.95
EVAPORATING BED – $16.98
SEDIMENT FILTER SYSTEM – $11.95
MAGNETIC SEPARATOR – $24.95

CENTRAL COMMODITY EXCHANGE
(select daily reading)

BEEF/head	– $215.20
BORAX /g	– $ 21.15
COPPER/g	– $ 95.10
CORN /BUSHEL	– $ 12.10
IRON ORE/g	– $ 85.70
GOLD /g	– $415.20
PULPWOOD /g	– $ 43.25
SALT /g	– $ 24.53
SILICA SAND/g	– $ 53.90
SILVER/g	– $120.25

UNITED MINE WORKERS (UMW) SALARY SCHEDULE
LOCAL # 95

BASIC SALARY

FOREMAN – $11.00 /hr.
COMMON LABORER – $ 8.00 /hr.

BENEFITS

The following benefits are to be included in the salaries of all workers:

MEDICAL (including dental) – $2.50/hr.
RETIREMENT – $ 1.50 /hr.

ASSOCIATED WITH AFL-CIO

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PROSPECTOR

ALLIED MINES

•PROSPECTOR'S REPORT•

MINE NAME

PROSPECTOR FILING REPORT

/ /

DATE OF REPORT

MINING PROCEDURE

EQUIPMENT REQUISITIONED

TOTAL MINE OUTPUT

SUBSTANCE	MASS(g)

MINER'S TIME CARD

STATUS	MINER		DAY 1	DAY 2	DAY 3	TOTAL TIME
FOREMAN		HOURS				
COMMON LABORER		TIME				
FOREMAN		HOURS				
COMMON LABORER		TIME				
FOREMAN		HOURS				
COMMON LABORER		TIME				
FOREMAN		HOURS				
COMMON LABORER		TIME				
FOREMAN		HOURS				
COMMON LABORER		TIME				

TOTAL HOURS WORKED

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EVALUATOR

ALLIED MINES

EVALUATOR'S ANNUAL REPORT TO THE BOARD

COST ANALYSIS

• INCOME •

MATERIAL	QUAN. (g) X PRICE/(g) =	TOTAL SALES
TOTAL (gross) INCOME		

TOTAL (gross) INCOME	
EQUIPMENT COST —	
PERSONNEL COST —	
NET INCOME	

• EXPENSES •

EQUIPMENT REQUISITIONED

ITEM	QUAN. X COST/UNIT =	TOTAL
TOTAL EQUIPMENT COST		

PERSONNEL EMPLOYEE	HRS. WORKED X WAGES/HR. =	TOTAL
TOTAL PERSONNEL COST		

EFFECTIVENESS STUDY

MATERIAL	RECOVERED AMOUNT ÷	ACTUAL AMOUNT X100 =	PERCENTAGE

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EVALUATOR

ALLIED MINES

RECOMMENDED ACTION:

- ☐ MAINTAIN OPEN MINE. CONTINUE PRESENT PROCEDURE.
- ☐ MAINTAIN OPEN MINE. REVIEW & EVALUATE PROCEDURE.
- ☐ TEMPORARILY CLOSE MINE. REVIEW & EVALUATE PROCEDURE.
- ☐ PERMANENTLY CLOSE MINE.
- ☐ OTHER (EXPLAIN)

EXPLANATION:

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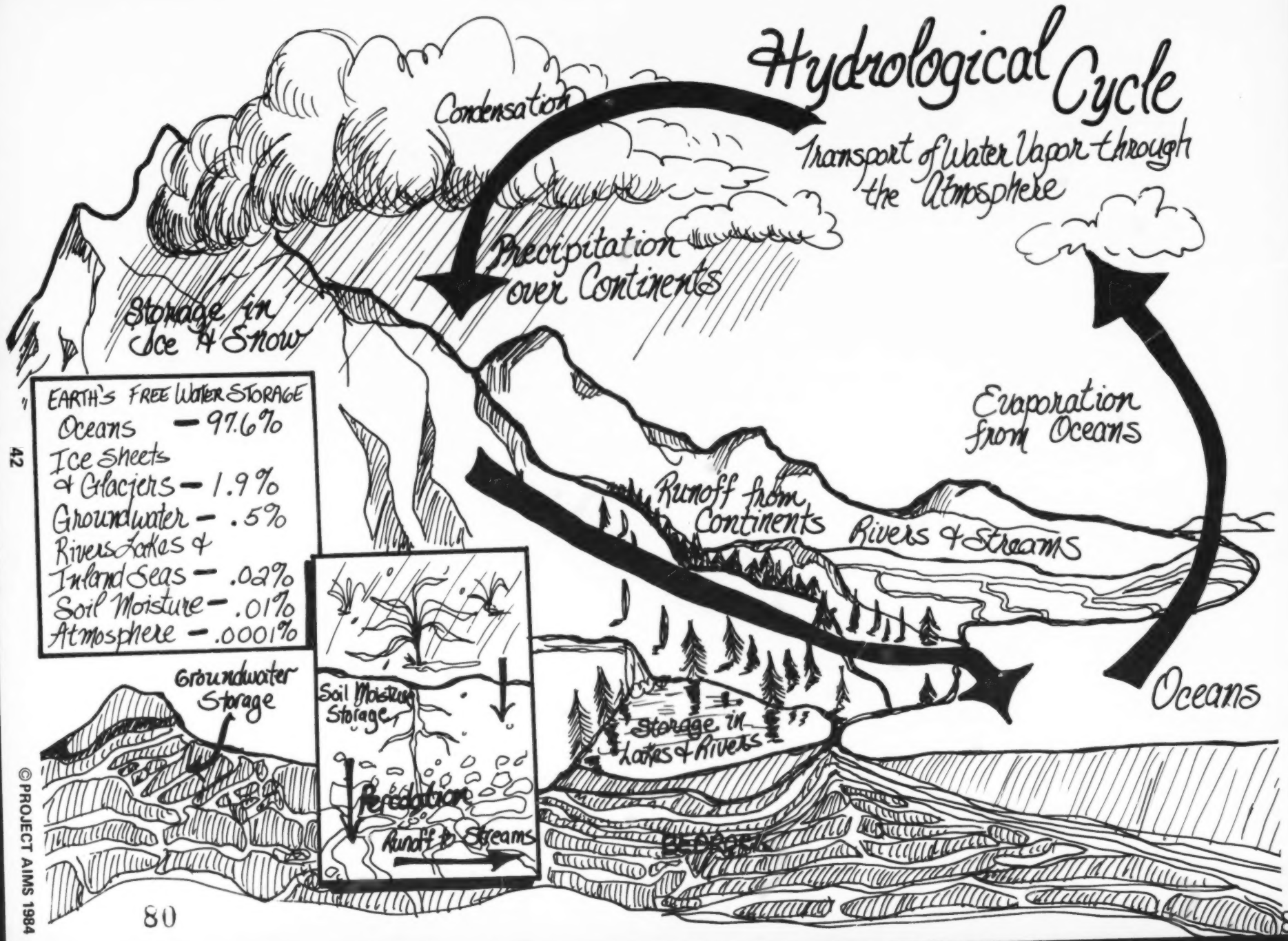

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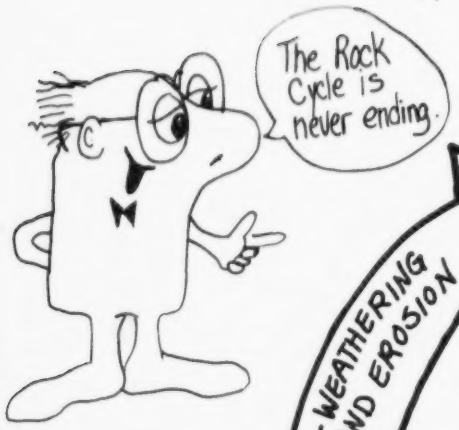
Rock formed of sediments - fragments of igneous, metamorphic or older sedimentary rocks. Sediments are carried by winds, water, or glaciers, then buried to harden into rock.



Cycle of Rock

SEDIMENTARY

UPLIFT - WEATHERING AND EROSION

BURIAL - HEAT AND PRESSURE

BURIAL - HEAT AND PRESSURE

UPLIFT - WEATHERING AND EROSION

PARENT OF ALL ROCKS

IGNEOUS

REARRANGEMENT OR RECRYSTALIZATION

METAMORPHIC

FUSION

Rocks formed by cooling and solidification of molten material.

Rock that has changed chemical composition of texture as a result of deformation or increased temperature.